DIVISION I
EARTHWORK

ITEM 100
MOBILIZATION

This item shall govern the mobilization of personnel, equipment and supplies at the project site in preparation for beginning work on other contract items. Mobilization shall include, but is not limited to, the movement of equipment, personnel, material, supplies, etc. to the project site and the establishment of office and other facilities necessary prior to beginning the work.

MEASUREMENT: Measurement of the Item, "Mobilization" as specified herein will be by the "Lump Sum", as the work progresses. Measurement of the item "Insurance and Bond" will be by lump sum not to exceed 3% of the total contract amount.

PAYMENTS: Partial payments of the "Lump Sum" bid for mobilization will be as follows: (The adjusted contract amount for construction items as used below is defined as the total contract amount less the lump sum bid for Mobilization.)

1) When 1% of the adjusted contract amount for construction items is earned, 50% of the mobilization lump sum bid or 5% of the total contract amount, whichever is less, will be paid.

2) When 5% of the adjusted contract amount for construction items is earned, 75% of the mobilization lump sum bid or 10% of the total contract amount, whichever is less, will be deducted from the above amount.

3) When 10% of the adjusted contract amount for construction items is earned, 90% of the mobilization lump sum bid or 15% of the total contract amount, whichever is less, will be paid. Previous payments under this item will be deducted from the above amount.

Upon completion of all work under this contract, payment for the remainder of the lump sum bid for "Mobilization" will be made.

Insurance and Bond will be payed as a lump sum on the initial request for payment.

BID ITEMS:

Item 100 - Mobilization - Lump Sum.
Item 100.1 - Insurance and Bond - Lump Sum (3%)

ITEM 101
PREPARING RIGHT-OF-WAY

This item shall govern preparing the right-of-way for construction operations by removing and disposing of all obstructions from the right-of-way and from designated easements where removal of such obstructions is not otherwise provided for in the plans and specifications.

Such obstructions shall be considered to include, but not limited to, remains of houses not completely removed by others, foundations, floor slabs, concrete, brick, lumber, plaster, cisterns, septic tanks, basements, abandoned utility pipes or conduits, equipment or other foundations, fences, retaining walls, outhouses, shacks, and all other debris as well as buried concrete slabs, curbs, driveways, and sidewalks.

This item shall also include the removal of trees, stumps, bushes, shrubs, brush, roots, vegetation, logs, rubbish, paved parking areas, miscellaneous stone, brick, drainage structures, manholes, inlets, abandoned railroad tracks, scrap iron and all debris, whether above or below ground, except live utility facilities.

This item shall not govern for the demolition of buildings by the use of explosives. Such demolition work shall be governed by the use of a special specification controlling the work.

It is the intent of this specification to provide for the removal and disposal of all obstructions to the new construction together with other objectionable materials not specifically provided for elsewhere by the plans and specifications.

Unless shown otherwise on the plans, all fences along the right-of-way which are damaged or removed temporarily by the Contractor shall be replaced by the Contractor to an equal or better condition at no additional cost to the City.

If the Contractor encounters hazardous substances, industrial waste, environmental damage, underground storage tanks, or conditions conducive to environmental damage, Contractor shall immediately stop work in the area affected and report the condition to the Owner's representative in writing. Contractor shall not be responsible for or required to conduct any investigation, site monitoring, containment, cleanup, removal, restoration or other

remedial work of any kind or nature (the "remedial work") under any applicable level, state or federal law, regulation or ordinance, or any judicial order. If the Contractor agrees in writing to commence and/or prosecute some or all of the remedial work, all costs and expenses, to include any extension of the contract time, of such remedial work shall be paid by Owner to Contractor as additional compensation.

CONSTRUCTION METHODS: Areas designated on the plans shall be cleared of all obstructions, vegetation, abandoned structures, etc., as defined above, except trees or shrubs specifically designated by the Engineer for preservation. Trees and shrubs designated for preservation shall be carefully trimmed as directed and shall be protected from scarring, barking, or other injuries during construction operations. Exposed ends of pruned

limbs shall be treated with an approved pruning material.

Unless otherwise indicated on the plans, all underground obstructions shall be removed to the following depths:

1.) In areas to receive embankment, 2 feet [610 mm] below natural ground.

2.) In areas to be excavated, 2 feet [610 mm] below the lowest elevation of the excavation.

3.) All other areas, 2 feet [610 mm] below natural ground.

Holes remaining after removal of all obstructions, objectionable materials, vegetation, etc. shall be backfilled and tamped as directed by the Inspector, and the entire area bladed to prevent ponding of water and to provide drainage. In areas that are to be immediately excavated, backfilling and blading may be eliminated if approved by the Inspector. Areas to be used as borrow sites and material sources shall have all obstructions, objectionable materials, vegetation, etc., removed to the complete extent necessary to prevent such objectionable matter from becoming mixed with the material to be used in the construction.

Where a conduit is shown to be replaced, it shall be removed in its entirety and all connections to the existing conduit shall be extended to the new line. Where an existing conduit is to be cut and plugged, the line shall be cut back not less that 2 feet [610 mm] and a plug of concrete not less that 2 feet [610 mm] long shall

be poured and held in the end of the pipe or the plug may be accomplished by using a precast stopper grouted into place.

Material to be removed will be designated as "salvageable" or "non-salvageable" on the plans prior to bidding by the Contractor. All "salvageable" material will remain the property of the City and will be stored at the site as directed by the Inspector. All "non-salvageable" materials and debris removed shall become the property of the Contractor and shall be removed from the site and shall be disposed of properly.

All asphaltic material shall be deposited of or recycled at a facility authorized to accept the asphalt for such purposes.

MEASUREMENT: "Preparing Right-of-Way" for new construction will be measured by the lump sum.

PAYMENT: This item will be paid for at the contract lump sum price bid for "Preparing Right-of-Way" , which price shall be full compensation for work herein specified, including the furnishing of all materials, equipment, tools, labor, and incidentals necessary to complete the work. The lump sum price will be pro-rated based on the number of phases in the project. A phase will be eligible for payment when street excavation is completed for that phase.

BID ITEM

Item 101: Preparing Right-of-Way, Lump Sum.

ITEM 102
OBLITERATING ABANDONED STREET

This item shall govern obliterating sections of abandoned streets in accordance with these specifications and in conformity to the lines, grades, and details shown on the plans or as established by the Engineer.

CONSTRUCTION METHODS: After the designated sections of the old street are no longer needed for traffic, the section shall be cut or filled to produce the finished grade shown on the plans, or as established by the Engineer. Where fill (Item 107) is required to bring the section up to the established grade, the existing surfacing (regardless of the material) shall be scarified or plowed to mix it effectively with the underlying earth. Excavated material from the project may be used to bring the section up to the established grade provided the said excavated material is free from objectionable objects such as rocks, roots, broken concrete, asphalt, etc., and the entire area shall be smoothed by blading or other approved methods. The material used and the smoothing method shall be subject to approval by the Inspector. Any old structures such as inlets, junction boxes, curbing, sidewalks, driveways, etc., shall be broken down to a minimum of 2 feet [610 mm] below the established finished grade. Inlets, junction boxes, and other such structures shall be completely backfilled so that no voids exist regardless of their respective depths below the finished grade. When designated on the plans that the area shall be sodded, Item No. 516 "Sodding" of these specifications shall apply.

MEASUREMENT: "Obliterating Abandoned Street" will be measured by the square yard of accepted work and no separate measurement of excavation, breaking down old structures, backfilling old structures or removing old curbing, sidewalks, driveways, etc. will be made. Any sodding required will be measured for under Item No. 516 "Sodding". Any fill required to bring the section to the established grade will be measured and paid for under Item No. 107, "Embankment".

PAYMENT: This item will be paid for at the contract price bid for "Obliterating Abandoned Street" which price shall be full compensation for all work herein specified, including all excavation and disposal of excavated material for scarifying, for breaking down structures and backfilling same, and for all labor, tools, equipment, and incidentals necessary to complete the work.

Sodding will be paid for under Item no. 516 "Sodding". Fill will be paid for under Item No. 107 "Embankment"

BID ITEM:

Item 102 - Obliterating Abandoned Street - Per square yard [square meters].

ITEM 103
REMOVE CONCRETE

This item shall govern the breaking up, removing, and satisfactorily disposing of existing concrete, as classified, at locations shown on the plans or as directed by the Engineer. Existing concrete not shown on the plans, located beneath the natural ground surface, not indicated by the Engineer or not obvious to the naked eye will not be covered under this item. Such materials will be removed as needed and paid for under ITEM 104 "Street Excavation", ITEM 105 "Channel excavation", or ITEM 306 "Structural Excavation".

CLASSIFICATION: Existing concrete to be removed under this item will be classified as follows:

1. "Concrete Curb" will include curb, curb and gutter, and low curb at driveways, and combinations thereof.

2. "Sidewalks and Driveways" will include concrete sidewalks and driveways.

CONSTRUCTION METHODS: The existing concrete shall be broken up, removed, and disposed of by the Contractor.

When only a portion of the existing concrete is to be removed, care shall be exercised to avoid damage to that portion to remain in place. The existing concrete shall be cut to neat lines shown on the plans or as established by the Engineer, by sawing with an appropriate type circular concrete saw to a minimum depth of 1/2-inch [13 mm] Any existing concrete which is damaged or destroyed beyond the neat lines so established shall be replaced at the Contractor's expense.

Where reinforcement is encountered in the removed portions of the concrete, a minimum of 1-foot [305 mm]shall be cleaned of all old concrete and left in place to tie into the new concrete construction.

MEASUREMENT: Concrete curb removed as prescribed above will be measured by the linear foot (linear meter) in its original position regardless of the thickness and reinforcing steel encountered.

Concrete sidewalks and driveways removed as prescribed above will be measured by the square foot [square meter] in its original position regardless of the thickness of the concrete and reinforcing steel encountered.

PAYMENT: This item will be paid for at the contract unit price bid for "Remove Concrete Curb" or "Remove Concrete Sidewalks and Driveways", which price shall be full compensation for all work herein specified, including the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the work.

BID ITEM:

Item 103.1 - Remove Concrete Curb - Per linear foot [meter]

Item 103.2 - Remove Sidewalks and Driveways - Per Square Foot. [Square Meter]

ITEM 104
STREET EXCAVATION

This item shall govern the excavating and proper utilization or otherwise satisfactory disposal of all excavated material, of whatever character, within the limits of the work and the constructing, compacting, and shaping and finishing of all earthwork on the entire length of the street and approaches in accordance with specification requirements herein outlined and in conformity with the required lines, grades, and typical cross sections, shown on the plans or directed by the Engineer.

CLASSIFICATION: All excavation shall be unclassified and shall include all materials encountered regardless of their nature or the manner in which they are removed, except those covered by other pay items of this contract.

If the Contractor encounters hazardous substances, industrial waste, environmental damage, underground storage tanks, or conditions conducive to environmental damage, Contractor shall immediately stop work in the area affected and report the condition to the Owner's representative in writing. Contractor shall not be responsible for or required to conduct any investigation, site monitoring, containment, cleanup, removal, restoration or other remedial work of any kind or nature (the "remedial work") under any applicable level, state or federal law, regulation or ordinance, or any judicial order. If the Contractor agrees in writing to commence and/or prosecute some or all of the remedial work, all costs and expenses, to include any extension of the contract time, of such remedial work shall be paid by Owner to Contractor as additional compensation.

All asphaltic material shall be disposed of or recycled at a facility authorized to accept the material for such purposes.

CONSTRUCTION METHODS: The subgrade shall be shaped in conformity with the typical sections shown on the plans and to the lines and grades established by the Engineer by the removal of existing material or addition of approved material. All unstable or otherwise objectionable material shall be removed from the subgrade and replaced with approved material. All earth cuts shall be scarified to a uniform depth of at least 6-inches [52 mm] below the required finished subgrade elevation. All holes, ruts, and depressions shall be filled with approved material. The surface of the subgrade shall be finished to the lines and grades as established and be in conformity with the typical sections shown on the plans. Any deviation in excess of 1/2-inch [13 mm] in cross section and in a length of 16-feet [4.9 m] measured longitudinally shall be corrected by loosening, adding, or removing material, reshaping and compacting by sprinkling and rolling. Sufficient subgrade shall be prepared in advance to insure satisfactory prosecution of the work.

Material removed in one area may be utilized in the addition of material to the subgrade in another area if approved by the Inspector. All material required for completion of the subgrade shall be subject to approval by the Inspector.

Subgrade materials shall be compacted by approved mechanical tamping equipment to an apparent dry density of the total material of not less than 90 percent of the maximum dry density as determined in accordance with TXDOT Test Method Tex-113-E. Tests for density will be made within 24 hours after compacting operations are completed. If the material fails to meet the density specified, it shall be re-worked as necessary to obtain the density required. If the City determines that the subgrade is unsuitable, the contractor will be required to remove the unsuitable material and replace it with suitable material. The contractor is responsible for compaction of trenches installed as a part of this contract. Just prior to placing any base materials, density and moisture content of the top 3 inches [76 mm] of compacted subgrade shall be checked and if tests show the density to be more than 2% below the specified minimum or the moisture content to be more than 3% above or below the optimum, the course shall be reworked as necessary to obtain the specified compaction and moisture content.

Unsuitable excavation or excavation in excess of that needed for construction shall be known as "Waste" and shall become the property of the Contractor and it shall become his sole responsibility to dispose of this material off the limits of the right-of-way.

MEASUREMENT: All accepted street excavation will be measured in its original position and the volume computed in cubic yards [cubic meters] by the method of average end areas. Cross-sectional areas shall be computed to the established line of the subgrade, to a vertical line behind the curb, as indicated

on the plans form the subgrade to the top of the proposed curb and then to the lines for parkway slopes as shown on the cross-sections of the plans.

PAYMENT: This item will be paid for at the contract unit price bid for "Street Excavation", which price shall be full compensation for all work herein specified, including the furnishing of all materials, equipment, tools, labor, and incidentals necessary to complete the work.

Authorized removal and replacement of unsuitable material shall be paid for at 200% of bid price for street excavation.

BID ITEM:

Item 104 - Street Excavation - Per cubic yard [cubic meter]

ITEM 105
CHANNEL EXCAVATION

This item shall govern the excavation for open channels within the limits shown on the plans, regardless of the type of material encountered; removing and properly utilizing or otherwise satisfactorily disposing of all excavated materials; and the constructing, shaping and finishing of all earthwork involved in conformity with the required lines, grades and cross sections, and in accordance with the plans and specification requirements.

This item does not apply to excavation required for box culvert conduits, either cast-in-place or precast, pipe storm sewers or for pipe sanitary sewers as excavation for those types of construction are governed by the conditions set forth in other specification items. Excavation for other small drainage structures such as manholes, inlets, junction boxes and outfall structures shall be governed and paid for under ITEM 306, "Structural Excavation". Such excavation will be considered as that beyond the limits of the channel excavation indicated on the plans.

CLASSIFICATION: All channel excavation will be unclassified, and shall include all materials encountered regardless of their nature or the manner in which they are removed.

If the Contractor encounters hazardous substances, industrial waste, environmental damage, underground storage tanks, or conditions conducive to environmental damage, Contractor shall immediately stop work in the area affected and report the condition to the Owner's representative in writing. Contractor shall not be responsible for or required to conduct any investigation, site monitoring, containment, cleanup, removal, restoration or other remedial work of any kind or nature (the "remedial work") under any applicable level, state or federal law, regulation or ordinance, or any judicial order. If the Contractor agrees in writing to commence and/or prosecute some or all of the remedial work, all costs and expenses, to include any extension of the contract time, of such remedial work shall be paid by Owner to Contractor as additional compensation.

All asphaltic material shall be disposed of or recycled at a facility authorized to accept the material for such purposes.

CONSTRUCTION METHODS:
All channel excavation shall be performed as specified herein and shall conform to the established alignment, grades and cross sections. Suitable excavated materials shall be utilized, insofar as practicable, in constructing required embankments, or backfilling around drainage structures.

Excavated materials which are unsuitable for embankments or backfilling, or excavation in excess of that needed for construction shall become the property of the Contractor and it shall become his sole responsibility to properly dispose of this material outside the limits of the project.

MEASUREMENT: Accepted channel excavation for open channels will be measured in its original position and the volume computed in cubic yards [cubic meters] by the method of average end areas in accordance with the lines, grades and cross sections shown on the plans.

PAYMENT: This item will be paid for at the contract unit price bid for "Channel Excavation", which price shall be full compensation for all work herein specified, including the furnishing of all materials, equipment, tools, labor, and incidentals necessary to complete the work.

BID ITEM:
Item 105 - Channel Excavation- per cubic yard.[cubic meter]

ITEM 106
BOX CULVERT EXCAVATION AND BACKFILLING

This item shall govern the excavation for placing of storm drainage box culverts, whether cast-in-place or precast, within the limits shown on the plans, regardless of the type of material encountered; removing and properly utilizing or otherwise satisfactorily disposing of all excavated materials; and the constructing, shaping, backfilling and finishing of all earthwork involved in conformity with the required lines, grades and cross sections, and in accordance with the plans and specification requirements herein outlined.

This item does not apply to excavation of open channels, or that required for pipe storm sewers or pipe sanitary sewers as excavation for those types of construction are governed by the conditions set forth in their respective specification requirements. Excavation required for other small drainage structures such as manholes, inlets, junction boxes and outfall structures shall be governed and paid for under Item 306, "Structural Excavation". Such excavation will be considered as that beyond the limits of box culvert excavation as indicated on the plans. Where a box culvert is used as a bridge in open channel construction, excavation shall be considered "Channel Excavation" as covered under Item 105, and as Item 306 "Structural Excavation" beyond the limits of the channel excavation.

CLASSIFICATION: All box culvert excavation will be unclassified, and shall include all materials encountered regardless of their nature or the manner in which they are removed.

If the Contractor encounters hazardous substances, industrial waste, environmental damage, underground storage tanks, or conditions conducive to environmental damage, Contractor shall immediately stop work in the area affected and report the condition to the Owner's representative in writing. Contractor shall not be responsible for or required to conduct any investigation, site monitoring, containment, cleanup, removal, restoration or other remedial work of any kind or nature (the "remedial work") under any applicable level, state or federal law, regulation or ordinance, or any judicial order. If the Contractor agrees in writing to commence and/or prosecute some or all of the remedial work, all costs and expenses, to include any extension of the contract time, of such remedial work shall be paid by Owner to Contractor as additional compensation.

All asphaltic material shall be disposed of or recycled at a facility authorized to accept the material for such purposes.

CONSTRUCTION METHODS: All box culvert excavation shall be performed as specified herein and shall conform to the established alignment, grades and cross sections or other limits indicated in the plans. Suitable excavated materials shall be utilized, insofar as practicable, in backfilling around the box culvert, or other drainage structures or in constructing required embankments, if applicable. Unsuitable materials below footing grade shall be removed and replaced with "Gravel Subgrade Filler", Item 410.

Excavated materials which are unsuitable for embankments or backfilling, or excavation in excess of that needed for construction shall become the property of the Contractor and it shall become his sole responsibility to properly dispose of this material outside the limits of the project.

Backfilling to the top of the box culvert (initial backfill) shall be done by one of the three methods (a), (b) (c) or (d) below. Backfilling from the top of the culvert to the top of the trench, or proposed subgrade elevation, shall be done in accordance with Item 400, "Backfill". Backfill behind walls shall not begin until the concrete has attained a compressive strength of 2000 psi [15 MPa]. Backfill on top of supporting slabs shall not begin until the concrete has attained a compressive strength of 3000 psi [20 MPa].

(a) Material for backfill shall be placed in uniform layers not more than 12 inches [305 mm] in depth (loose measurement) and shall be compacted to the density specified herein. Each layer of backfill material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density, by means of a mechanical tamper.
All compaction shall be such that the apparent dry density of each layer shall be not less than 90% of the maximum dry density as determined by tests on samples as outlined in TXDOT Method Tex 113-E, unless otherwise shown on the plans.

(b) A clean gravel, or gravel approved by the Engineer, conforming to the requirements of Item No.410, "Subgrade Filler" may be used for backfill material from the bottom of the trench to the top of the conduit. The gravel shall be placed in the trench and lightly tamped to consolidate and seat the mass against conduit and earthen surfaces.

A filter fabric shall be placed between the gravel backfill (initial backfill) and secondary backfill. The filter material shall have an apparent opening size of U.S. Sieve No. 40.

(c) Where conditions permit and with approval of the Engineer, a gravel conforming to Item 200 "Flexible Base" may be used from the top of the gravel filter bed to the top of the box culvert. This backfill material shall be placed in uniform layers not more than 12 inches [305 mm] in depth (loose measurement) and shall be compacted to the required density. Each layer of material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density by means of a mechanical tamper.
(d) Controlled low strength material (CLSM). CLSM shall be placed by direct discharge from a mixer truck or other approved method. A minimum of 30 psi.[.2 MPa] at 3 days and maximum strength of 800 psi. [6 MPa] at 28 days is required. There is no separate pay item for Controlled Low Strength Material.

MEASUREMENT: Accepted box culvert excavation will be measured in its original position and the volume computed in cubic yards [cubic meters] by the method of average end areas in accordance with the line, grade and limits shown on the plans. Backfill will not be measured for payment. Filter material will not be measured for payment.

PAYMENT: This item shall be paid for at the contract unit price bid for "Box Culvert Excavation and Backfill". Replacement of unsuitable material with gravel subgrade will be paid for under Item 410. Price bid shall be full compensation for all work herein specified, including excavating all material, backfilling, compacting, furnishing all materials, equipment, tools, labor, and incidentals necessary to complete the work.

BID ITEM:
Item 106 - Box Culvert Excavation and Backfill - per cubic yard [cubic meter]

ITEM 107
EMBANKMENT

This item shall govern the placing and compacting of suitable materials obtained from approved sources for utilization in the construction of street embankments, berms, levees, dykes, channels, and obliterating streets.

MATERIAL: Material may be furnished from required excavation in the areas shown in the plans or from other sources obtained by the contractor and having a plasticity index not exceeding 20.

CONSTRUCTION METHODS:

1. General: Prior to placing any embankment, all "Preparing Right-of- Way" operations shall have been completed on the areas over which the embankment is to be placed. Stump holes or other small excavations in the limits of the embankments shall be backfilled with suitable material and thoroughly tamped by approved methods before commencing embankment construction. The surface of the ground, including plowed loosened ground, or surface roughened by small washes, etc., shall be restored to approximately its original slope where indicated on plans or required by the Engineer. The ground surface thus prepared shall be compacted by sprinkling and rolling.

Unless otherwise indicated on plans, the surface of the ground of all unpaved areas other than rock which are to receive embankment shall be loosened by scarifying or plowing to a depth of not less than 4 inches [102 mm]. The loosened material shall be recompacted with the new embankment as hereinafter specified.

Where indicated on plans or directed by the Engineer, the surface of hillsides to receive embankment shall be loosened by scarifying or plowing to a depth of not less than 4 inches [102 mm], or cut into steps before embankment materials are placed. The embankment shall then be placed in layers, as hereinafter specified, beginning at the low side in partial width layers and increasing the widths as the embankment is raised. The material which has been loosened shall be recompacted simultaneously with the embankment material placed at the same location.

Where embankments are to be placed adjacent to or over existing roadbeds, the roadbed slopes shall be plowed or scarified to a depth of not less than six inches [152 mm] and the embankment built up in successive layers, as hereinafter specified, to the level of the old roadbed before its height is increased. Then if directed, the top of the old roadbed shall be scarified, and recompacted with the next layer of the new embankment. The total depth of the scarified and added material shall not exceed the permissible depth layer.

Trees, stumps, roots, vegetation, or other unsuitable materials shall not be placed in embankment.

Except as otherwise required by the plans, all embankment shall be constructed in layers approximately parallel to the finished grade of the roadbed and unless otherwise specified, each layer shall be so constructed so to provide a uniform slope of 1/4 inch per foot [25 milimeters per meter] from the center line of the roadbed to the outside, except that on super elevated curvers, each layer shall be constructed to conform to the super elevation required by the plans.

Embankments shall be constructed to the grade established by the Engineer and completed embankments shall correspond to the general shape of the typical sections shown on the plans. Each section of the embankment shall correspond to the detailed section or slopes established by the Engineer. After completion of the roadway, it shall be continuously maintained to its finished section and grade until the project is accepted.

2. Earth Embankment: Earth embankments shall be defined as those composed principally of material other than rock, and shall be constructed of accepted material from approved sources.

Except as otherwise specified, earth embankments shall be constructed in successive layers 12 inches [305 mm] compacted for the full width of the individual roadway cross section and in such lengths as are best suited to the sprinkling and compaction methods utilized.

Minor quantities of rock encountered in constructing earth embankment shall be incorporated in the specified embankment layers, or may be placed in accordance with the requirements for the construction of rock embankments in the deeper fills, provided such placement of rock is not immediately adjacent to structures.

Each layer of embankment shall be uniform as to material, density and moisture content before beginning compaction. Where layers of unlike materials abut each other, each layer shall be feather edged for at least 100 feet [30 m] or the material shall

be so mixed as to prevent abrupt changes in the soil. No material placed in the embankment by dumping in a pile or windrow shall be incorporated in a layer in that position, but all such piles or windrows shall be moved by blading or similar methods. Clods or lumps of material shall be broken and the embankment material mixed by blading, harrowing, disking or similar methods to the end that a uniform material of uniform density is secured in each layer. Water required for sprinkling to bring the material to the moisture content necessary for maximum compaction shall be evenly applied and it shall be the responsibility of the Contractor to secure a uniform moisture content throughout the layer by such methods as may be necessary.

All earth cuts, full width or part width hill side cuts, which are not required to be excavated below subgrade elevation for base and backfill, shall be scarified to a uniform depth of at least 6 inches [152 mm] below grade, and the material shall be mixed and reshaped by blading and then sprinkled and rolled in accordance with the requirements outlined above for each embankment and to the same density as that required for the adjacent embankment.

Compaction of embankments shall be obtained by the "Density Control" method.

3. Density Control:

Each layer shall be compacted to the required density by any method, type, and size of equipment which will give the required compaction. Prior to and in conjunction with the rolling operation, each layer shall be brought to the moisture content necessary to obtain the required density and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer.

For each layer of earth embankment and select material, it is the intent of this specification to provide the density as required herein, unless otherwise shown on the plans. Soils shall be sprinkled as required and compacted to the extent necessary to provide not less than 90 percent of the maximum dry density as determined in accordance with TXDOT Test method Tex-113-E.

After each layer of earth embankment or select material is complete, tests as necessary will be made by the Inspector. If the material fails to meet the density specified, the course shall be reworked as necessary to obtain the specified compaction.

Just prior to placing any base materials, density and moisture content of the top 3 inches [76 mm] of compacted subgrade shall be checked and if tests show the density to be more than 2 percent below the specified minimum or the moisture content to be more than 3 percent above or below the optimum, the course shall be reworked as necessary to obtain the specified compaction and moisture content.

4. Rock Embankments: Rock embankments shall be defined as those composed principally of rock, and shall be constructed of accepted material from approved sources.

Except as otherwise specified, rock embankments, normally shall be constructed in successive layers for the full width of the individual roadway cross section and of 18 inches [457 mm] or less in depth. When, in the opinion of the Inspector, the rock sizes necessitate a greater depth of layer and the height of fill will permit, the layer depth may be increased as necessary, but in no case shall the depth of layer exceed 2 1/2 feet [762 mm]. Each layer shall be constructed by starting at one end and dumping the rock on top of the layer being constructed then pushing the material ahead with an approved "Bulldozer" in such manner that the larger rock will be placed on the ground or preceding embankment layer and the interstices between the larger stones will be filled with small stones and spalls by this operation and from the placing of succeeding loads of material.

The maximum dimension of any rock used in embankment shall be less than the depth of the embankment layer, and in no case shall any rock over 2-feet [610 mm] in it greatest dimension be placed in the embankment. All oversized rock which is otherwise suitable for construction shall be broken to the required dimension and utilized in embankment construction where proposed by plans, except that when preferred by the Contractor and acceptable to the Engineer, such rock may be placed at other points where the embankment layer is of greater depth, thus requiring less breakage.

Unless otherwise provided, the upper or final layer of the embankment shall contain no stones larger than 4 inches [102 mm] in their greatest dimension, and shall be composed of material so graded that the density and uniformity of the surface layer may be secured by the methods and requirements as set forth for "Density Control" method.

Each layer shall be compacted to the required density as outlined for "Earth Embankment", except in those layers where rock will make density testing difficult, the Inspector may accept the layer by visual inspection.

At Culverts and Bridges: Embankments adjacent to culverts and bridges which cannot be compacted by use of the blading and rolling equipment used in compacting the adjoining sections of embankment shall be compacted in the manner prescribed under Item 400, "Excavation, Trenching and Backfilling".

As a general rule embankment material placed adjacent to any portion of any structure and in the first two layers above the top of any culvert or similar structure shall be earth, free of any appreciable amount of gravel or stone particles more than 4-inches [102 mm] in the greatest dimension and of such gradation as to permit

thorough compaction. When, in the opinion of the Inspector, such material is not readily available, the use of rock or gravel mixed with earth will be permitted in which case no particles larger than 12-inches [305 mm] in greatest dimension and 6-inches [152 mm] in the least dimension may be used and the percentage of fines shall be sufficient to fill all voids and insure a uniform and thoroughly compacted mass of proper density.

MEASUREMENT: All accepted embankment will be measured in place and the volume computed in cubic yards [cubic meters] by the method of average end areas. No allowance will be made for shrinkage.

PAYMENT: This item will be paid for at the contract unit price bid for "Embankment", which price shall be full compensation for all work herein specified, including the furnishing of all materials, equipment, tools, labor, and incidentals necessary to complete the work.

BID ITEM:

Item 107 - Embankment - per cubic yard [cubic meter].

ITEM 108
LIME TREATMENT FOR SUBGRADE

This item shall govern for treating the subgrade by the pulverizing, addition of lime, mixing and compacting the mixed material to the required density. This item applies to both natural ground or embankment type subgrades and shall be constructed as specified herein and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Engineer.

MATERIALS: Lime for this item shall conform to the requirements for "Type A, Hydrated Lime", or "Type B, Commercial Lime Slurry" or "Type C: Quicklime" of Item No. 264 "Hydrated Lime and Lime Slurry" of the Texas Department of Transportation Standard Specifications. The Contractor shall select, prior to construction, the grade to be used and shall notify the Engineer in writing before changing from one grade to another.

EQUIPMENT: The machinery, tools and equipment necessary for proper prosecution of the work shall be on the project and approved by the Inspector prior to the beginning of construction operations. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner. Lime weight verification: When lime is furnished in trucks, the weight of lime shall be determined on certified scales and delivered to the job site with exit ports sealed at the plant.

CONSTRUCTION METHODS:

1. General. The completed course shall be uniformly treated, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

2. Preparation of Subgrade or Existing Base. Prior to treating existing material, it shall be shaped to conform to the typical sections, as shown on the plans.

Before pulverizing or scarifying an existing material, when directed by the Inspector, the Contractor shall proof roll the roadbed in accordance with Item 216, "Rolling (Proof)". Soft spots shall be corrected as directed by the Inspector.

When the contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a uniform surface over the entire width of the cut. The machine shall provide a visible indication of the depth of cut at all times.

In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the plans or as established by the Engineer.

3. Pulverization. The existing pavement or base material shall be pulverized or scarified so that 100 % shall pass the 2 inch sieve.

4. Application. The percentage by weight or pounds per square yard [square meter] of lime to be added will be as shown on the plans and may be varied by the Engineer if conditions warrant.

Lime shall be spread only on that area where the mixing operations can be completed during the same working day, except as required for quicklime.

Unless otherwise approved by the Engineer, the lime operation shall not be started when the air temperature is below 40°F [4 °C] and falling, but may be started when the air temperature is above 35 °F [2 °C] and rising. The temperature will be taken in the shade and away from artificial heat. Lime shall not be placed when weather conditions in the opinion of the Inspector are unsuitable.

The application and mixing of lime with the material shall be accomplished by the methods herein described as "Dry Placing" or "Slurry Placing". Type A Hydrated Lime shall be applied by "Slurry Placing" unless otherwise shown on the plans or approved by the Engineer. Type B Commercial Lime Slurry shall be applied by "Slurry Placing". Type C Quicklime shall be applied by "Slurry Placing" or "Dry Placing" as shown on the plans. When Type C Quicklime is used for dry placement, it shall be Grade "DS". When Type C Quicklime is used for slurry placement, it shall be either Grade "DS" or Grade "S". Grade "S" shall be used in slurry placement only.

CAUTION: *Use of quicklime can be dangerous. Users should be informed of the recommended precautions in handling, storage and use of quicklime.*

(a) Slurry Placing. When type A Hydrated Lime is specified and slurry placement is to be used, the Type A Hydrated Lime shall be mixed with water to form a slurry with a solids content approved by the Engineer.

Type B Commercial Lime Slurry shall be delivered to the project in slurry form at or above the minimum dry solids content approved by the Engineer. The distribution of lime at the rate(s) shown on the plans or approved by the Engineer shall be attained by successive passes over a measured section of roadway until the proper lime content has been secured.

When Type C Quicklime is applied as a slurry, the amount of dry quicklime shall be 80 percent of the amount shown on the plans. The slurry shall contain at least the minimum dry solids content approved by the Engineer. The residue from the slurrying procedure shall be spread uniformly over the length of the roadway currently being processed unless otherwise approved by the Engineer. This residue is primarily inert material with little stabilizing value, but may contain a small amount of quicklime particles that slake slowly. A concentration of these particles could cause the compacted stabilized material to swell during slaking.

(b) Dry Placing. The lime shall be distributed by an approved spreader at the rate shown on the plans or as directed by the Engineer. The lime shall be distributed at a uniform rate and in such a manner as to reduce the scattering of lime by the wind. The material shall be sprinkled as approved by the Inspector.

Slurry Consistency Requirements

Slurry shall be of such consistency that it can be applied uniformly without difficulty.

When the distributor truck is not equipped with an agitator, the Contractor shall have a standby pump available on the project for agitating the lime and water as required by the Engineer in case of undue delays in dispersing the slurry.

5. Mixing. The mixing procedure shall be the same for "Dry Placing" or "Slurry Placing" as herein described.

During the interval between application and mixing, hydrated lime that has been exposed to the open air for a period of six (6) hours or more or to excessive loss due to washing or blowing will not be accepted for payment.

(a) First Mixing:
The material and lime shall be thoroughly mixed. The material and lime shall be brought to the proper moisture content and be left to cure a minimum of 48 hours as approved by the Engineer.

In addition to the above, when Type C Quicklime, Grade "DS", is used under "Dry Placing", the material and lime shall be mixed as thoroughly as possible at the time of the lime application. Sufficient moisture shall be added during the mixing to hydrate the quicklime. After mixing, and prior to compaction, the mixture of material, quicklime and water shall be moist cured for a minimum of 48 hours as approved by the Engineer.

During the curing period, the material shall be kept moist as directed by the Inspector.

When shown on the plans or approved by the Engineer, the pulverization requirement may be waived when the material contains a substantial quantity of aggregate.

(b) Final Mixing:
After the required curing time, the material shall be uniformly mixed by approved methods. If the soil binder-lime mixture contains clods, they shall be reduced in size by raking, blading, discing, harrowing, scarifying or the use of other approved pulverization methods.

Following mixing, a sample of the material at roadway moisture will be obtained for pulverization testing. All nonslaking aggregates retained on the 3/4 inch sieve will be removed from the sample. The remainder of the material shall meet the following pulverization requirement when tested by TXDOT Test Method Tex-101-E, Part III:

Minimum passing 1 3/4" sieve..... 100

Minimum passing 3/4" sieve..... 80

(6) Compaction Methods. Prior to compaction, the material shall be aerated or sprinkled as necessary to provide the optimum moisture. Compaction of the mixture shall begin immediately after final mixing, and in no case, later than 3 calendar days after the final mixing.

Compaction shall continue until the entire depth of the mixture is uniformly compacted by "Density Control". Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Engineer.

a) Density Control. Each course shall be sprinkled as required and compacted to the extent necessary to provide not less than 90 percent of the optimum density for areas that will receive subsequent subbase or base courses. Not less than 95 percent of the optimum density will be required for areas that will receive surface courses.

When the material fails to meet the density requirements, or should the material lose the required stability, density or finish before the next course is placed, or the project is accepted, it shall be reworked as specified below.

(7) Reworking a Section. When a section is reworked within 72 hours after completion of compaction, the Contractor shall rework the section to provide the required compaction. When a section is reworked more than 72 hours after completion of compaction, the contractor shall add 25 percent of the specified rate of lime. Reworking shall include loosening, road mixing as approved by the Engineer, compacting, and finishing. When a section is reworked, a new optimum density will be determined from the reworked material in accordance with TXDOT Test Method Tex-121-E, part II.

(8) Finishing and Curing. After the final layer or course of the lime treated material has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections.

The completed section shall then be finished by rolling with a pneumatic tire or other suitable roller. The completed section shall be moist cured or prevented from drying by addition of an asphalt material at the rate of 0.05 to 0.20 gallons per square yard [0.2 to 0.9 Liters per square meter]. Curing shall continue for 7 days before further courses are added or traffic is permitted, unless otherwise approved by the Inspector.

However, the lime treated material may be covered by other courses, the day following finishing, when approved by the Inspector. When the plans provide for the treated material to be covered by other courses of material, the next course shall be applied within 14 calendar days after final compaction is completed, unless otherwise approved by the Inspector.

MEASUREMENT: Lime treatment of the subgrade shall be measured by the square yard [square meter] of completed subgrade in place, to the depth specified and to the neat lines, grades and cross sections shown on the plans.

When Type A, Hydrated Lime is used, the quantity of lime will be measured by the ton of 2,000 pounds [1 megagram], dry weight.

When Type B, Commercial Lime Slurry, is used, the quantity of lime used will be calculated from the required minimum percent solids based upon the use of Grade 1, Grade 2 or Grade 3 as follows:

Grade 1: The "Dry Solids Content" shall be at least 31 percent by weight of the slurry and the quantity of lime will be calculated by the ton of 2,000 pounds [1 megagram] based on the 31 percent, as delivered on the road.

Grade 2: The "Dry Solids Content" shall be at least 35 percent by weight of the slurry and the quantity of lime will be calculated by the ton of 2,000 pounds [1 megagram] based on the 35 percent, as delivered on the road.

Grade 3: The "Dry Solids Content" shall be at least 46 percent by weight of the slurry and the quantity of lime will be calculated by the ton of 2,000 pounds [1 megagram] based on the 46 percent, as delivered on the road.

When Type C: Quicklime is used, the quantity of lime will be measured by the ton of 2000 pounds [1 megagram] dry weight.

PAYMENT: Work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for as follows:

"Lime" will be paid for at the unit price bid per ton of 2,000 pounds [1 megagram] for "Lime" of the type specified, not to exceed 1% of the calculated quantity (based on delivered weight), which price shall be full compensation for furnishing all lime.

"Lime Treatment for Subgrade" will be paid for at the contract unit price bid per square yard [square meter], which price shall be full compensation for all correction of secondary subgrade, for loosening, mixing, pulverizing, spreading, drying, application of lime, water content of the slurry, shaping and maintaining, for all sprinkling and rolling, for all manipulations required, for all hauling and freight involved, for all tools, equipment, labor and incidentals necessary to complete the work.

BID ITEM:

Item 108.1 - Lime Treatment for Subgrade
(___ inches [mm] compacted depth) - per square yard [square meter].

Item 108.2 - Lime - per ton [metric ton].

ITEM NO.109
PORTLAND CEMENT STABILIZATION FOR SUBGRADE SOILS

This Item shall govern for treating subgrade, by the addition of portland cement and water, for pulverizing, mixing, and compacting the mixed material to the required density, as herein specified and in conformity with the typical sections, lines, grades and thickness as shown on the plans.

MATERIALS:

Soil. Soil shall consist of approved material, free from vegetation or other objectionable matter encountered in the existing roadbed section and other acceptable material used in the preparation of the roadbed in accordance with this specification.

Portland Cement. Portland Cement shall be ASTM C150 Type I or II Portland Cement.

The Contractor, at his option, may use bulk cement, provided the apparatus for handling, weighing and spreading the cement is approved by the Inspector. Cement weights shall be certified at the point of origin.

Water. Water shall be clean and free of oil, acid, alkali, organic mater, or other deleterious substances. Water which is suitable for drinking or ordinary household uses may be accepted for use without being tested.

CONSTRUCTION METHODS

(1) General. The completed course shall have a uniformly treated subgrade material containing a uniform Portland Cement mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

(2) Preparation of Subgrade. Prior to scarifying or pulverizing existing material, the subgrade shall be shaped to conform to the typical sections as shown on the plans.

When directed by the Inspector, the contractor shall proof roll the roadbed in accordance with Item 216, "Rolling (Proof)", before pulverizing or scarifying existing material. Soft spots shall be corrected as directed by the Inspector.

When the Contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a smooth surface over the entire width of the cut. The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.

In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the plans. Then the windrowed material shall be uniformly replaced before cement is applied.

(3) Application of Cement. Portland cement shall be spread uniformly by an approved dry or slurry method on the soil at the rate specified on the plans or as determined by preliminary laboratory tests. If a bulk cement spreader is used, it shall be positioned by string lines or other approved method during spreading to insure a uniform distribution of cement. Cement should be applied only to such an area that all the operations can be continuous and completed in one operation. However, in the event that seasonal rain has saturated the subgrade resulting in high moisture contents in the insitu material, cement may be applied at one-half the specified rate to dry out the area. The remainder of the application rate of cement shall be applied the following day(s), not to exceed 48 hours.

Unless otherwise approved by the Inspector, the cement treatment operation shall not be started when the air temperature is below 40 ^{O}F [4 ^{O}C] and falling, but may be placed when the air temperature is above 35 ^{O}F [2 ^{O}C] and rising. The temperature will be taken in the shade and away from artificial heat. Cement shall not be placed when weather conditions in the opinion of the Inspector are unsuitable.

The percentage of moisture in the subgrade soil at the time of cement application shall not exceed the quantity that shall permit uniform and intimate mixing of soil and cement during dry-mixing operations; and it shall not exceed the specified optimum moisture content for the soil and cement mixture as described in 109.6 below.

No equipment, except that used in the spreading and mixing, shall be allowed to pass over the freshly spread cement until it is mixed with the soil.

(4) Mixing & Processing. The mixing procedure shall be the same for "Dry Placing" or "Slurry Placing" as described herein. The subgrade and cement shall be thoroughly mixed by approved road mixers or other approved equipment, and the mixing shall continue until, in the opinion of the Inspector, a homogeneous, friable mixture of material and cement is obtained, free from all clods or lumps, and kept moist as directed by the Inspector.

(5) Pulverization. The soil shall be so pulverized that, at the completion of moist mixing, when all non-slaking aggregates retained on the No. 4 Sieve are removed, the remaining material shall meet the following requirements when tested from the roadway in the roadway condition by Test Method Tex-101-E (Part III).

Minimum Passing 1 3/4-inch Sieve 100%

Minimum Passing 3/4-inch Sieve 85%

(6) Compaction. Compaction shall begin immediately after final mixing. The material shall be compacted to 95% of the maximum density, as established, and in accordance with Test Method Tex 113-E. It shall be aerated or wetted as necessary to provide optimum moisture. Moisture tolerances shall be as described below.

Description:

For cement treated subgrade that will receive subsequent courses.

Density, Percent

Not less than 95, except when shown otherwise on the plans.

Moisture, Percent

Within 2.5% of optimum unless otherwise shown on the plans.

Prior to the beginning of compaction, the mixture shal be in a loose condition for its full depth. Compaction shall begin at the bottom and shall continue until the entire depth of the mixture is uniformly compacted.

In-place density tests shall be as outlined in Test Method Tex 114-E or Test Method Tex 115-E. In-place density tests shall be performed at the rate of one per 300 linear feet [90 m] of paving for two lanes. The suitability of the stabilization shall be confirmed by Atterberg Limit testing at the rate of one test per 2,500 cubic yards [1900 cubic meters] of processed material.

In addition to the requirements specified for density, the full depth of the material shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests as necessary will be made by the Engineer. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements. Throughout this entire operation, the shape of the course shall be smooth and in conformity with the typical section shown on the plans and to the established lines and grades. Should the material, due to any reason or cause, lose the stability, density and finish before the next course is placed or the work is accepted, it shall be recompacted and refinished at the sole expense of the CONTRACTOR.

(7) Finishing and Preparation for Surfacing. After the final layer or course of the cement treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The completed section shall then be finished by rolling as directed with a pneumatic tire or other suitable roller sufficiently light to prevent hair cracking. No curing membrane is required; preparation for final surfacing may begin immediately.

MEASUREMENT: The work performed and material furnished as prescribed by this item will be measured as follows.

Cement treatment for materials in place will be measured by the square yard [square meter] to lines as shown on the typical sections.

Portland Cement specified by the Engineer for incorporation in the cement treatment will be measured per ton of 2,000 pounds [1 megagram] of cement.

PAYMENT: The work performed and material furnished as prescribed by this item and measured in accordance with the method indicated on the plans and proposal and in accordance with the applicable provisions of "Measurement" above will be paid for at the unit price bid for "Cement Treatment (Existing Materials)" and "Portland Cement".

The unit prices bid shall each be full compensation for preparing the roadbed; for furnishing all material; for all freight involved; for furnishing scales and labor involved in weighing the material; for pulverizing, applying cement, water, all processing, mixing, spreading, sprinkling, compacting, finishing and curing the cement treated soil; and for all manipulations, labor, equipment, fuels, tools and incidentals necessary to complete the work.

BID ITEM:

Item 109.1 - Cement Treatment of Subgrade (__ inches [mm] compacted depth) - per square yard [square meter].

DIVISION II
BASE & SURFACE COURSES

ITEM 200
FLEXIBLE BASE

This item shall govern for a foundation course for surfacing, pavement, or other base courses composed of crushed stone, and constructed as herein specified in one or more courses in conformity with the typical sections shown on the plans and to the lines and grades as established by the Engineer.

MATERIAL: The material shall be crushed as necessary to meet the requirements hereinafter specified, and shall consist of durable stone crushed and/or screened to the required particle size, with or without other approved fine sized material. The material shall be from approved sources.

Testing of flexible base materials shall be in accordance with the following TXDOT standard laboratory test procedures:

Preparation for Soil Constants and Sieve Analysis	Tex-101-E
Liquid Limit	Tex-104-E
Plastic Limit	Tex-105-E
Plasticity Index	Tex-106-E
Linear Shrinkage	Tex-107-E
Sieve Analysis	Tex-110-E
Los Angeles Abrasion	ASTM C131 (Grad. A)

Samples for testing the material shall be taken prior to the compaction operations.

The material shall be well graded and when properly tested, shall meet the following requirements:

Retained on 1-3/4 inch sieve	0%
Retained on No. 4 sieve	45 to 75%
Retained on No. 40 sieve	60 to 85%

The material passing the No. 40 sieve shall be known as Soil Binder and shall meet the following requirements:

Liquid Limit shall not exceed	40
Plasticity Index shall not exceed	12

The crushed stone shall have an abrasion of not more than forty (40) when subjected to the Los Angeles Abrasion Test.

CONSTRUCTION METHODS: The flexible base material shall be placed on the approved subgrade in courses not to exceed 6-inches [152 mm] compacted depth. It shall be the responsibility of the Contractor that the required amount of material be delivered and uniformly spread and shaped. All material shall be moved from the place where it is dumped by cutting into windrows. After the material has been cut into windrows, it shall be sprinkled, spread, shaped, and rolled in proper sequence to prevent segregation and as necessary for required compaction.

The surface upon completion shall be smooth and in conformity with typical sections and to the established lines and grades. Any deviation in excess of 1/4-inch [6 mm] in cross section and in length of 16-feet [4.9 m] measured longitudinally shall be corrected. All irregularities, depressions, or weak spots which develop shall be corrected.

Flexible base shall be compacted to an apparent dry density of not less than 95 percent of the maximum dry density as determined in accordance with THD Test Method Tex 113-E. Tests for density will be made within 24 hours after compaction operations are completed. If the material fails to meet the density specified, it shall be reworked as necessary to meet the density required. Just prior to the placing of any succeeding course of flexible base or surfacing on a previously completed course, the density and moisture of the top 3-inches [76 mm] of flexible base shall be checked and if test show the density to be more than 2 percent below the specified minimum or the moisture content to be more than 3 percent above or below the optimum, the course shall be reworked as necessary to obtain the specified compaction and moisture content.

MEASUREMENT: "Flexible Base" will be measured by the square yard [square meter], complete in place, for the thickness specified on the plans, or by the cubic yard [cubic meter], complete in place as indicated in the proposal.

PAYMENT: This item will be paid for at the contract unit price bid for "Flexible Base" which price shall be full compensation for all work herein specified, including the furnishing, hauling, and placing of all materials, for all water required, and for all equipment, tools, labor, and incidentals necessary to complete the work.

BID ITEMS:

Item 200.1 - 6 inches [152 mm] compacted depth per square yard [square meter].

Item 200.2 - 8 inches [203 mm] compacted depth per square yard [square meter].

Item 200.3 - 10 inches [254 mm] compacted depth per square yard (square meter).

Item 200.4 - 12 inches [305 mm] compacted depth per square yard [square meter].

Item 200.5 - 14 inches [356 mm] compacted depth per square yard [square meter].

Item 200.6 - Flexible Base (complete in place) per cubic yard [cubic meter]

ITEM 201
CEMENT STABILIZED BASE

This item shall govern for the use of selected base material and Portland Cement, uniformly mixed, moistened, and compacted in accordance with these specifications and shaped to the lines, grades, and typical sections of the plans.

MATERIAL: Base material shall be crushed or uncrushed as necessary to meet the requirements hereinafter specified in Item 200, "Flexible Base". The material shall be well graded and when properly tested shall meet the following requirements:

Retained on 1-3/4 inch sieve	0%
Retained on No. 4 sieve	45 to 75%
Retained on No. 40 sieve	60 to 85%

The material passing the 40 mesh sieve shall be known as "Soil Binder" and shall meet the following requirements:

Liquid Limit shall not exceed	40
Plasticity Index shall not exceed	12

(Note: The linear shrinkage shall be calculated from the volumetric shrinkage at the liquid limit.)

The crushed stone shall have an abrasion of not more than 40 when subjected to the Los Angeles Abrasion Test.

Water shall be free from substances deleterious to the hardening of the treated base.

Cement shall be Type 1 Portland Cement of a standard brand and shall conform to the requirements of ASTM Designation C-150.

One bag, containing 1 cubic foot of cement shall be considered as weighing 94 pounds [40 kg] net. One barrel of cement shall be considered as weighing 376 pounds [171 kg] net, and containing 4 cubic feet [0.1 cubic meter].

Contractors, at their option, may use bulk cement, provided the apparatus for handling and spreading the cement is approved by the Engineer. Bulk cement shall be weighed on platform scales or standard plant batch weighing equipment approved by the Engineer.

Cement delivered in bags shall be plainly marked with the brand name of the manufacturer. All bags shall be in good condition at the time of delivery. Cement salvaged from discharge or used bags shall not be permitted.

Any cement kept in storage shall be stored in a suitable weathertight building which will protect the cement from dampness. Any cement which for any reason becomes partially set or which contains hard lumps or cakes shall be rejected.

Cement shall be applied at the rate of 4.93 puonds per square yard for 1 inch depth [2 kilograms per square meter per 25 milimeter depth].

"RC-2" and "MC-30" Liquid Asphalt used as a seal shall meet the requirements set forth in TXDOT Item 300, "Asphalts, Oils and Emulsions".

EQUIPMENT: All equipment necessary to properly perform and complete the work shall be on the project prior to beginning the work, shall be subject to the approval of the Inspector, and shall be maintained in a satisfactory condition at all times.

The following list of equipment shall be considered the minimum necessary for cement stabilized base work:

1. A single pass traveling mixing plant may be used if it can be made to meet the exact requirements of this specification.

2. In lieu of a traveling mixing plant, the following equipment shall be used for the "Mixed-in-Place" method of processing:

a. 1 - Motor Grader

b. 1 - 7 foot [2.1 m] self powered, self-propelled, heavy duty rotary speed mixer.

Motor graders shall be self-propelled, shall have tandem or four wheel drive, shall have a blade length of not less than 12 feet [3.7 m], shall have a wheel base length of (the distance between front and rear axles) of not less than 16 feet [4.9 m], and shall be tight and in

good operating condition and approved by the Inspector.

Cement shall be distributed by cement spreaders equipped with hoppers of adequate capacity to prevent spillage. The proportioning and distributing devices shall be positive in action and capable of necessary adjustments in quantity of cement spread and width of lane spread. The spreader shall be so designed that its' accuracy is not varied by changing conditions of the surface over which it operates. The cement spreader shall distribute cement to an accuracy of 5 percent of theoretical quantity per square yard and shall be approved by the Inspector.

Compaction equipment shall be of sufficient weight and adequately loaded to accomplish the required compaction.

Water distributors shall be equipped with positive and rapidly working cut off valves, approved spray bar equipped with bituminous nozzles and a power pump that will insure distribution of water in a uniform and controllable rate of application. Spray bars shall be so constructed that the effective length may be easily and quickly altered.

All equipment shall meet these specifications and be approved by the Inspector. Equipment may be eliminated or substituted only upon approval of the Engineer.

Nothing in this section shall relieve the Contractor of his responsibility for producing finished work of the quality specified.

TEST SECTION: If the Contractor has had no previous experience in construction of "Cement Stabilized Base", he shall be required to construct a "Test Section" in accordance with the following:

The first section of each cement treated course shall serve as a test section. Its length (not less than 350 linear feet [107 m] or more than 500 linear feet [152 m]) shall be determined by the capability of the equipment to perform the work. In case it is found that the work is not satisfactory with respect to the specification requirements, the Contractor shall revise his procedures and augment or replace equipment as necessary to assure work completed in accordance with the specifications. Additional test sections may be required as directed by the Engineer. Test sections not conforming to the requirements of the specifications shall be reconstructed.

CONSTRUCTION METHODS:

General: It is the intent of this specification to obtain a complete course or courses of cement stabilized base of uniform moisture and density, containing a uniform mixture of cement; a closely knit surface free from laminations, cracks, ridges, or loose material and to the surface requirements hereinafter specified. It shall be the responsibility of the Contractor to furnish adequate equipment and regulate his sequence of operation in such a manner as to provide a cement treated course or courses with the proper amount of cement for the depth as shown on the plans and to maintain or reconstruct the course or courses as necessary to conform to the specific requirements specified.

Placing of Base Material: After approval of the subgrade, base material shall be delivered on the road and placed in windrows of uniform sections, then accurately bladed and shaped to required crown and grade to provide a base of compacted depth required by the plans.

Final Preparation of Section: On the day immediately preceding processing, water, as required, shall be added and uniformly mixed full depth with the base material. This operation shall precede cement spreading by at least 12 hours. The section shall then be accurately bladed and shaped to required grade and section.

Application of Cement: The specified quantity of Portland Cement required for the full depth of treatment shall be uniformly spread over the surface. Each pass of the cement spreader shall be positioned by either the curb line or a string line. Cement shall be applied only to such areas as can be completed as herein specified within the daylight hours of the same day. No equipment, except that used in spreading and mixing, will be allowed to pass over the freshly spread cement until it is mixed with the base material.

Mixing and Processing: Either method (a) or (b) below may be used at the option of the Contractor. Method (c) shall be used only on sections less than 200 linear feet [61 m] in length.

(a) Multiple-Pass Traveling Mixing Plant: After the cement has been applied, it shall be mixed with the base or subbase material a maximum of 12-inches to 15-inches [305 mm - 381 mm] in depth. Mixing shall continue until the cement has been sufficiently blended with the base or subbase material to prevent the formation of cement balls when water is applied. Any mixture that has not been compacted and finished shall not remain undisturbed for more than 30 minutes.

Immediately after the mixing of base or subbase material and cement is completed, water, as necessary, shall be uniformly applied and incorporated into the mixture. Proper care shall be exercised to insure proper moisture distribution at all times. After the last increment of water has been added, mixing shall continue until a thorough and uniform mix has been obtained.

(b) Single-Pass Traveling Mixing Plant: After the cement has been applied, it shall be sufficiently mixed with the base or subbase material to prevent the formation of cement balls when water is applied. Unpulverized soil lumps in the mixture will not be allowed. Should this condition prevail, the Contractor shall "pre-wet" the raw base or subbase material as necessary to correct this condition.

The mixer shall be provided with means for visibly and accurately gaging the water application. The water shall be applied uniformly through a pressure spray bar. After cement is spread, mixing operations shall proceed as follows:

The mixer shall, in one continuous operation, mix the base or subbase material and cement full depth, add the required moisture uniformly, thoroughly moist-mix the material, cement, and water, spread the completed mixture evenly over the machine processed width of the subgrade, and leave it in a loose condition ready for immediate compaction.

The mixture shall not remain undisturbed, after mixing and before compacting, for more than 30 minutes.

(c) Blade Mixing: On sections of street of 200 linear feet [61 m] or less and with the approval of the Inspector, the requirements for mixing equipment may be waived and the cement mixed with a motor grader.

Immediately after the cement has been distributed, the material shall be scarified full depth and the cement mixed with the loose base material for the full depth of the treatment by blading into windrows. Mixing shall continue until the cement has been sufficiently blended with the base material to prevent formation of cement balls when water is applied.

Immediately after the mixing of base material and cement is complete, water as necessary shall be uniformly applied and incorporated into the mixture. Pressurized equipment and supply provided shall be adequate to insure continuous application of the required amount of water to the section being processed. Proper care shall be exercised to insure proper moisture distribution at all times. After the last increment of water has been added, mixing shall continue until a thorough and uniform mix has been obtained.

Compaction and Finishing: The material shall be compacted to not less than 98 percent of the maximum dry density as determined by the TXDOT Test Method Tex 120-E. At the start of compaction, the percentage of moisture in the mixture shall be less than that quantity which will cause the mixture to become unstable during compaction and finishing.

The surface upon completion shall be smooth and in conformity with typical sections and to the established lines and grades. Any deviation in excess of 1/4 inch [6 mm] in cross section and in a length of 16-feet [5 m] measured longitudinally shall be corrected. All irregularities, depression, or weak spots which develop shall be corrected.

All sections of cement stabilized base shall be processed full width each day without longitudinal construction joints.

The density of the cement stabilized base shall be determined by the inspector after construction. Any portion which has a density below that specified herein and which has not properly hardened after a suitable time interval shall be removed and replaced to meet this specification at the expense of the Contractor.

PROTECTION AND COVER: The completed cement treated base course shall be protected against rapid drying by applying a minimum of 0.20 gallons per square yard [0.9 liters per square meter] of RC-2 Liquid Asphalt, or a minimum of 0.15 gallons per square yard [0.7 liter per square meter] of MC 30. The actual amounts may be varied in the field by the Inspector to insure that a complete and adequate seal is achieved. This curing seal shall be applied as soon as practicable, but not later than eight hours after the completion of final compaction. The surface shall be kept moist until the curing seal is applied. It shall be the responsibility of the Contractor to protect the asphalt membrane from being picked up by traffic by either sanding or dusting the surface.

The curing period shall be a minimum of 14 days (24 hours each) with a minimum temperature of 40 ^{O}F [4 ^{O}C], unless waived by the Engineer.

WEATHER LIMITATIONS: Cement stabilized base construction shall not begin unless the temperature is at least 40 ^{O}F [4 ^{O}C] in the shade and rising or when the wind velocity exceeds 15 MPH [24 km/h] The Contractor is responsible for the quality of the base under any weather conditions.

TRAFFIC: The Contractor shall not be permitted to drive heavy equipment over completed portions, but pneumatic-tired equipment required for hauling cement and water may be permitted after the surface has hardened sufficiently to prevent the equipment from marring the surface, provided protection and cover specified herein are not impaired. The cement stabilized base may be opened to local traffic as soon as the RC-2 has been applied and dusted or sanded as necessary to prevent it from being picked up by traffic. It may be opened to all traffic after 7 days.

MAINTENANCE: The Contractor shall be required to maintain at his own expense the entire cement stabilized base within the limits of his contract in good condition satisfactory to the Inspector from the

time he first starts work until all work shall have been completed.

Maintenance shall include immediate repairs of any defect that may occur after construction, which work shall be done by the Contractor at his own expense and repeated as often as necessary to keep the area continuously intact. Repairs are to be made in a manner to insure restoration of a uniform surface of good quality cement stabilized base. Faulty work shall be replaced for the full depth of base. Any low area shall be remedied by replacing the material for the full depth of treatment, rather than adding a thin layer of base material to the completed work.

MEASUREMENT: Accepted Cement Stabilized Base will be measured by the square yard [square meter], complete in place, for the thickness specified on the plans. Areas will be measured separately for the various thicknesses of Cement Stabilized Base.

Portland Cement, actually incorporated in the completed work, will be measured by the ton [megagram].

PAYMENT: "Cement Stabilized Base" of the depth specified, completed and accepted, will be paid for at the unit price bid per square yard [square meter], which price shall be full compensation for furnishing all materials, including asphaltic seal, except the Portland Cement, for all royalty and freight involved, for delivering base materials on the site, for all processing, mixing, drying, incorporation of Portland Cement and water, spreading, sprinkling, shaping, compacting, finishing and curing the cement stabilized base, and for all manipulations, labor, equipment, tools, and incidentals necessary for completion of work.

BID ITEM:

Item 201.1 - Cement Stabilized Base (6-inches [152 mm] compacted depth) - per square yard [square meter].

Item 201.2 - Cement Stabilized Base (_____inches [mm]compacted depth) - per square yard [square meter].

Item 201.3 - Portland Cement - per ton [megagram].

ITEM 202
PRIME COAT

This item shall govern for the application of asphaltic material on the completed base course and/or other approved areas in accordance with these specifications as and directed by the inspector.

MATERIALS: The asphaltic material for Prime Coat shall meet the requirements for Cut-Back Asphalt, "MC-30", Emulsified Asphalt "EA-11M" or "EA-10S', or other asphalts or emulsions as shown on the plans, or as directed, or approved, by the Engineer. Asphalts and Emulsions shall conform to the requirements of Item 300, "Asphalts, Oils and Emulsions' of the Standard Specifications of the Texas Department of Transportation. Where Emulsified Asphalts are used, the amount of emulsified asphalt as a percentage by volume of the total mixture shall be within the limits shown on the plans, or shall be of a percentage as directed by the Engineer.

CONSTRUCTION METHODS: When, in the opinion of the inspector, the area and/or base is satisfactory to receive the prime coat, the surface shall be cleaned by sweeping with a vacuum sweeper or other approved methods as directed by the Inspector. If directed by the Inspector, the surface shall be lightly sprinkled with water just prior to application of the asphaltic material. The asphaltic material shall be applied on the clean surface by an approved type of self-propelled pressure distributor so operated as to distribute the prime coat at a rate not to exceed 0.20 gallon per square yard [0.2 liters per square meter] of surface, evenly and smoothly, under a pressure necessary for proper distribution. During the application of prime coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutters or structures.

Prime Coat shall not be applied when the air temperature is below 60 ^{O}F [16 ^{O}C] and falling, but it may be applied when the air temperature is above 50 ^{O}F [10 ^{O}C]. and is rising; the air temperature being taken in the shade and away from artificial heat. Asphaltic material shall not be placed when general weather conditions, in the opinion of the Inspector, are not suitable.

MEASUREMENT: The asphaltic material for prime coat will be measured at the point of delivery on the project in gallons [liters] at the applied temperature. The quantity to be paid for shall be the number of gallons [liters] of asphaltic material used, as directed, in the accepted prime coat to the pay limits as shown on the plans. When emulsions are used, only that percentage of emulsified asphalt as a percentage by volume of the total mixture shall be paid for by the gallon [liter] of asphaltic material used in the accepted prime coat. Water used will not be measured for payment.

PAYMENT: The work performed and materials furnished as prescribed by this item will be paid for at the contract unit price bid per gallon for "Prime Coat", which price shall be full compensation for cleaning the area and/or base; for furnishing, heating, hauling and distributing the prime coat as specified; for all freight involved, and for all manipulations, labor, tools, equipment, and incidentals necessary to complete the work.

BID ITEM:
Item 202 - Prime Coat - per gallon [liter].

ITEM 203
TACK COAT

This item shall govern for the application of asphaltic material on the completed base course after the prime coat has sufficiently cured, existing pavement, bituminous surface, or in the case of a bridge, on the prepared floor slab in accordance with these specifications and as directed by the Inspector.

MATERIALS: The asphaltic material used for Tack Coat shall meet the requirements for 'Asphalt Cement", "Cut-Back Asphalt" or "Emulsified Asphalt" in Item No. 300, "Asphalts, Oils and Emulsions" of the Texas Department of Transportation Standard Specifications. The asphaltic material used for Tack Coat shall be that type or grade shown on the plans, or shall be as directed, or approved, by the Engineer.

CONSTRUCTION METHODS: Before the tack coat is applied, the surface shall be cleaned thoroughly with a vacuum sweeper to the satisfaction of the Inspector. The asphaltic material shall be applied on the clean surface by an approved type of self-propelled pressure distributor, so operated as to distribute the tack coat at a rate not to exceed 0.10 gallon per square yard [0.5 liter per square meter] of surface, evenly and smoothly under a pressure necessary for proper distribution. Where the pavement mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Inspector. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform coat of the asphaltic material used for tack coat. During the application of tack coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutters or structures.

MEASUREMENT: The asphaltic material for tack coat will be measured at point of delivery on the project in gallons [liters] at the applied temperature. The quantity to be paid for shall be the number of gallons [liters] of asphaltic material used, as directed, in the accepted tack coat. Water used with Emulsions will not be measured for payment.

PAYMENT: The work performed and materials furnished as prescribed by this item will be paid for at the contract unit price bid per gallon [liter] for "Tack Coat" which price shall be full compensation for cleaning the surface, for furnishing, heating, hauling and distributing the tack coat as specified; for all freight involved; and for all manipulations, labor, tools, equipment, and incidentals necessary to complete the work.

BID ITEM:
Item 203 - Tack Coat - per gallon [liter].

ITEM 204
SURFACE TREATMENTS

This item shall govern for construction of a surface treatment composed of a single or double application of asphalt material, each covered with aggregate, constructed on existing pavements or on the prepared base course or surface in accordance with these specifications. This item shall also govern for the furnishing and placing of aggregates. Quantities for the different types of surfaces and materials will be shown on the plans.

MATERIALS:

All materials shall be of the type(s) and grade(s) as shown on the plans and shall conform to the pertinent material requirements of the following TXDOT items.

Item 300, "Asphalts, Oils and Emulsions"
Item 302, "Aggregate for Surface Treatments".

Gradation requirements when tested by TXDOT Test Method Tex-200-F, Part I, shall be as shown on the plans.

EQUIPMENT:

(1) DISTRIBUTOR:
The distributor shall be a self-propelled pressure type, equipped with an asphaltic material heater and a distributing pump capable of pumping the material at the specified rate through the distributor spray bar. The distributor spray bar shall be capable of fully circulating the asphaltic material. The distributor spray bar shall contain nipples and valves so constructed that the nipples will not become partially plugged with congealing asphaltic material, in order to prevent streaking or irregular distribution of asphaltic material. Distributor equipment shall include a tachometer, pressure gauges, volume measuring devices, and a thermometer for reading the temperature of tank contents.

The distributor tank shall have been calibrated within three (3) years from the date it is first used on this project. The tank calibration procedure shall be in accordance with Test Method Tex-922-K, Part 1, and shall be signed and sealed by a registered professional engineer. Unless otherwise shown on the plans, the Contractor shall provide the tank calibration and shall furnish the Inspector an accurate and satisfactory calibration record prior to beginning the work. The Inspector may at any time verify calibration accuracy

in accordance with Test Method Tex-922-K, Part II, and may perform the recalibration if the calibration is found to be in error.

When a uniform application on asphaltic material is not being achieved, the Inspector may require that the spray bars on the distributor be controlled by an operator riding in such a position at the rear of the distributor that the operation of all sprays is in full view.

(2) AGGREGATE SPREADER:
A self-propelled continuous-feed aggregate spreader shall be used which will uniformly spread aggregate at the rate specified by the Engineer.

(3) ROLLERS:
Rolling equipment shall meet the governing specifications for Item 210, "Rolling (Pneumatic Tire)".

(4) SWEEPERS:
The broom shall be a rotary, self-propelled power broom for cleaning existing surfaces.

Vacuum sweepers or other approved equally capable equipment shall be suitable for removing loose aggregate from the compacted seal coat.

(5) ASPHALT STORING AND HANDLING EQUIPMENT:
All equipment used in storing or handling asphaltic material shall be kept clean and in good operating condition at all times and shall be operated in such a manner that there will be no contamination of the asphaltic material. The Contractor shall provide and maintain a recording thermometer to continuously indicate the temperature of the asphaltic material at the storage heating unit when storing of asphalt is permitted.

CONSTRUCTION METHOD:

(1) GENERAL:
Prior to surface treatment, all dirt and other objectionable material shall be removed from the existing pavement by sweeping or other approved methods. All existing raised pavement markings shall be removed daily, as the work progresses, and as approved by the Inspector. All vegetation found in the existing pavement shall be destroyed by an approved chemical killer.

Building paper shall be placed over all manholes, valve boxes, grates, etc., so as to protect the surfaces from asphaltic materials. Asphaltic materials shall not be placed, lapped, or splashed onto adjacent structures.

Surface treatments shall not be applied when the air temperature is below 60° F (16° C) and is falling, but it may be applied when the air temperature is 50° F (10° C) and is rising, the air temperature being taken in the shade and away from artificial heat. Surface treatments shall not be applied when the roadway surface temperature is below 60° F [16 °C] or when in the opinion of the Engineer, general weather conditions are not suitable. When latex modified asphalt cement is specified, surface treatments shall not be applied when the air temperature is below 80° F [27 °C] and is falling, but may be applied when the air temperature is above 70° F [21 °C] and is rising and shall not be applied when the temperature of the surface on which the surface treatment is to be applied is below 70° F [21 °C]. When asphaltic materials designed for cool weather placement are used, application may occur whenever the air and surface temperatures are acceptable to the Inspector. Asphaltic material shall not be placed when general weather conditions, in the opinion of the Inspector, are not suitable.

If it is found necessary by the Inspector, the surface shall be lightly sprinkled with water just prior to the first application of asphaltic material.

Asphalt and aggregate rates as shown on the plans are for estimating purposes only and may be varied as directed by the Engineer.

The Inspector will select the temperature of application within the limits recommended in TXDOT Item 300, "Asphalts, Oils and Emulsions". The Contractor shall apply the asphalt at a temperature within 15° F [9 °C] of the temperature selected.

The width of each application of asphaltic material shall be such to allow uniform application and immediate covering with aggregate. The Contractor shall be responsible for uniform application of asphaltic material at the junction of distributor loads. Paper or other suitable material shall be used to prevent overlapping of transverse joints. Longitudinal joints shall match lane lines unless otherwise authorized by the Inspector. Application of asphaltic material will be measured as necessary to determine the rate of application. In those areas where the asphalt distributor is not accessible, hand spraying may be permitted as directed by the Inspector.

After all rolling, the finished surface, all parkways, private property, and driveways adjacent to the work shall be cleared of any surplus aggregate by the Contractor by sweeping. Until the work has been accepted, additional sweeping shall be required as often as necessary so that loose aggregate does not present a hazard to traffic.

(2) ONE COURSE SURFACE TREATMENTS OR FIRST COURSE OF A TWO COURSE SURFACE TREATMENT:

Asphaltic material shall be applied by an approved distributor so operated as to distribute the material under a pressure necessary for uniform distribution.

Aggregate shall be immediately and uniformly applied and spread in the same width as the application of asphaltic material by the specified aggregate spreader, unless otherwise authorized by the Inspector.

After applying the aggregate, the entire surface shall then be broomed or raked as required by the Inspector and shall be thoroughly rolled with the type or types of rollers specified herein or as shown on the plans.

The Contractor shall be responsible for the maintenance of the surface treatment until the work is accepted by the Inspector. All holes or failures in the surface shall be repaired by use of additional asphalt and aggregate. All fat or bleeding surfaces shall be covered with approved cover material in such a manner that the asphaltic material will not adhere to or be picked up by the wheels of vehicles.

(3) TWO COURSE SURFACE TREATMENTS:

It is the intent of this specification that the application of asphalt and aggregate for multiple courses be applied within the same day, or immediately thereafter, and prior to opening the roadway to traffic.

The asphaltic material for each course of the surface treatment shall be applied and covered with aggregate in the same manner specified for the first application. Each surface shall then be broomed or raked as required by the Inspector and thoroughly rolled as specified for the first course. Asphaltic material and aggregate for each course shall be applied at the rates directed by the Inspector.

The Contractor shall be responsible for the maintenance of each course until covered by the succeeding courses or until the work is accepted by the Inspector. All holes or failures in the surface shall be repaired by use of additional asphalt and aggregate. All fat or bleeding surfaces shall be covered with approved cover material in such a manner that the asphaltic material will not adhere to or be picked up by the wheels of vehicles.

MEASUREMENT:

"Surface Treatment" will be measured by the completed and and accepted square yard [square meter] of either one course or two course applications.

PAYMENT:

The work performed as prescribed by this item will be paid for at the contract unit price bid per square yard [square meter] for "Surface Treatment", which price shall be full compensation for furnishing and placing all materials, sweeping, rolling, manipulations, labor, tools, equipment, and incidentals necessary to complete the work.

BID ITEM:

Item 204 .1 - One Course Surface Treatment - per square yard [square meter].

Item 204.2 - Two Course Surface Treatment - per square yard [square meter].

ITEM 205
HOT MIX ASPHALTIC CONCRETE PAVEMENT

This item shall govern for the installation of a base course, a leveling-up course, a surface course or any combination of these courses as shown on the plans, each to be composed of a compacted mixture of mineral aggregate and asphaltic material. The pavement shall be constructed on the previously completed and approved subgrade, base, existing pavement, bituminous surface or in the case of bridges, on the prepared floor slab, as herein specified and in accordance with the details shown on the plans.

MATERIALS: Materials used in Hot Mix Asphaltic Concrete Pavement shall meet the requirements as set forth in Item 340, "Hot Mix Asphaltic Concrete Pavement" of the Texas Department of Transportation Standard Specifications.

Reclaimed asphalt pavement (RAP) may be used in asphalt pavement mixes. Surface and level-up coures may have a maximum of 20% RAP and base course mixtures may have a maximum of 30% RAP.

PAVING MIXTURES: Paving mixtures used shall be Types B, C, or D as shown an the plans. The paving mixtures shall consist of a uniform mixture of aggregate, hot asphalt cement, and additives if allowed or required. The mix shall be designed in accordance with TXDOT Construction Bulletin C-14 and Test Method Tex-204-F. The mixture shall be designed to produce an acceptable mixture at an optimum density of 96.0 percent, when tested in accordance with Test Method Tex-207-F and Test Method Tex-227-F. The operating range for control of laboratory density during production shall be optimum density plus or minus 1.5 percent. The materials used in the mixture design shall produce a mixture with a stability value of at least 35, unless otherwise shown on the plans, when tested in accordance with Test Method Tex-208-F.

RECLAIMED ASPHALT PAVEMENT (RAP): Rapis define as a salvaged, pulverized, broken or crushed asphalt pavement. The RAP to be used in the mix shall be crushed or broken to the extent that 100% will pass the two inch sieve.

The stockpiled RAP shall not be contaminated by dirt or other materials. Unless otherwise shown on the plans, stocked piled, crushed RAP shall have either a decantation of 5% or less or a placisity index of eight (8) or less, when tested in accordance with test method TEX-406-a, part I, or TEX-106-E, respectively. This requirement applies to stockpiles from which the asphalt has not been removed by extraction.

EQUIPMENT:
(1) General: All equipment for the handling of all materials, mixing, placing and compacting of the mixture shall be maintained in good repair and operating condition and subject to the approval of the Engineer. Any equipment found to be defective and potentially having a negative effect on the quality of the paving mixture or ride quality will not be allowed.

(2) Spreading and Finishing Machine. The spreading and finishing machine shall be approved by the Engineer and shall meet the requirements indicated below.

(a) Screed Unit. The spreading and finishing machine shall be equipped with a heated compacting screed. It shall produce a finished surface meeting the requirements of the typical cross sections and the surface test.

Extensions added to the screed shall be provided with the same compacting action and heating capability as the main screed unit, except for use on variable depth tapered areas and/or as approved by the Engineer.

The spreading and finishing machine shall be equipped with an approved automatic dual longitudinal screed control system and automatic transverse screed control system. The longitudinal controls shall be capable of operating from any longitudinal grade reference including a stringline, ski, mobile stringline, or matching shoe.

The Contractor shall furnish all equipment required for grade reference. It shall be maintained in good operating condition by personnel trained in the use of this type of equipment.

The grade reference used by the Contractor may be of any type approved by the Engineer. The contractor shall set the grade reference to have sufficient support

so that the maximum deflection shall not exceed 1/16 inch [2 mm] between supports.

(b) Tractor Unit. The tractor unit shall be equipped with a hydraulic hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the mixture is being unloaded.

No portion of the weight of hauling equipment, other than the connection, shall be supported by the asphalt paver. No vibrations or other motions of the loading equipment, which could have a detrimental effect on the riding quality of the completed pavement, shall be transmitted to the paver.

The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel to obtain the desired lines and grades without resorting to hand finishing will not be allowed.

(3) Material Transfer Equipment. Equipment to transfer mixture from the hauling units or the roadbed to the spreading and finishing machine will be allowed unless otherwise shown on the plans. A specific type of material transfer equipment shall be required when shown on the plans.

(4) Motor Grader. The motor grader, when used, shall be a self-propelled motor grader and shall be equipped with smooth tread pneumatic tired wheels unless otherwise directed. It shall have a blade length of not less than 12 feet [3.7 m] and a wheelbase of not less than 16 feet [4.8 m].

(5) Rollers. Rollers provided shall meet the requirements for their type as follows:

(a) Pneumatic-Tire Roller. The roller shall be an acceptable medium pneumatic tire roller conforming to the requirements of Item 213, "Rolling (Pneumatic Tire)", Type B. Pneumatic-tire rollers used for compaction shall provide a minimum 80 psi [550 kPa] ground contact pressure. When used for kneading and sealing the surface only, they shall provide a minimum of 55 psi [380 kPa] ground contact pressure.

(b) Two-Axle Tandem Roller. This roller shall be an acceptable self-propelled tandem roller weighing not less than 8 tons [7.2 megagrams].

(c) Three-Wheel Roller. This roller shall be an acceptable self-propelled three wheel roller weighing not less than 10 tons [9.1 megagrams].

(d) Three-Axle Tandem Roller. This roller shall be an acceptable self-propelled three axle roller weighing not less than 10 tons [9.1 megagrams].

(e) Trench Roller. This roller shall be an acceptable self-propelled trench roller equipped with a sprinkler for keeping the wheels wet and an adjustable road wheel so that the roller may be kept level during rolling. The drive wheel shall be not less than 20 inches [500 mm] wide. The roller under working conditions shall produce not less than 325 pounds per linear inch [5800 kg] of roller width and be so geared that a speed of approximately 1.8 miles per hour (3 km/h) is obtained in low gear.

(f) Vibratory Steel-Wheel Roller. This roller shall have a minimum weight of 6 tons [5.4 megagrams]. The compactor shall be equipped with amplitude and frequency controls and shall be specifically designed to compact the material on which it is used.

(g) Straightedges and Templates. When directed by the Inspector, the Contractor shall provide acceptable 10 foot [3 m] straight edges for surface testing.

CONSTRUCTION METHODS:

(1) General. It shall be the responsibility of the Contractor to produce, transport, place and compact the specified paving mixture in accordance with the requirements herein.

The asphaltic mixture, when placed with a spreading and finishing machine, or the tack coat shall be placed when the air temperature is at least 50° F [10 °C].

The asphaltic mixture, when placed with a motor grader, shall not be placed when the air temperature is below 55° F [13 °C]. and is falling, but may be placed when the air temperature is above 45° F [7 °C] and is rising. The air temperature shall be taken in the shade away from artificial heat. The maximum depth of asphalt mixture placed with a motor grader will not exceed 5 inches [127 mm] of compacted material.

Mat thicknesses of 1-1/2 inches [38 mm] and less shall not be placed when the temperature of the surface on which the mat is to be placed is below 50° F [10 °C].

It is further provided that the tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions, temperature and moisture condition of the base, in the opinion of the Inspector are suitable.

If, after being discharged from the mixer and prior to placing, the temperature of the asphaltic mixture falls below 200° F [93 °C], all or any part of the load may be rejected and payment will not be made for the rejected material.

(2) Tack Coat. The surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the Inspector. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. Thick tack coat shall be

applied, as directed by the Engineer, with an approved sprayer at a rate not to exceed 0.10 gallon residual asphalt per square yard [0.45 liters per square meter] of surface. Where the mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Inspector. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform application of tack coat. During the application of tack coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutter and structures.

(3) Transporting Asphaltic Concrete. The asphaltic mixture shall be hauled to the work site in tight vehicles previously cleaned of all foreign material. The dispatching of the vehicles shall be arranged so that all material delivered is placed and all rolling completed during daylight hours unless otherwise shown on the plans. In cool weather or for long hauls, covering and insulating of the truck bodies may be required. If necessary, to prevent the mixture from adhering to the inside of the truck body, the inside of the truck may be given a light coating of release agent satisfactory to the Engineer.

(4) Placing.

(a) The asphaltic mixture shall be dumped and spread on the approved prepared surface with the spreading and finishing machine. When properly compacted, the finished pavement, shall be smooth, of uniform texture and density and shall meet the requirements of the typical cross sections and the surface tests. In addition, the placing of the asphaltic mixture shall be done without tearing, shoving, gouging or segregating the mixture and without producing streaks in the mat.

Unloading into the finishing machine shall be controlled so that bouncing or jarring the spreading and finishing machine shall not occur and the required lines and grades shall be obtained without resorting to hand finishing.

(b) When approved by the Engineer, level-up courses may be spread with a motor grader.

(c) The spreading and finishing machine shall be operated at a uniform forward speed consistent with the plant production rate, hauling capability, and roller train capacity to result in a continuous operation. The speed shall be slow enough that stopping between trucks is not ordinarily required. If, in the opinion of the Inspector, sporadic delivery of material is adversely affecting the mat, the Inspector may require paving operations to cease until acceptable methods are provided to minimize starting and stopping of the paver.

The hopper flow gates of the spreading and finishing machine shall be adjusted to provide an adequate and consistent flow of material. These shall result in enough material being delivered to the augers so that they are operating approximately 85 percent of the time or more. The augers shall provide means to supply adequate flow of material to the center of the paver. Augers shall supply an adequate flow of material for the full width of the mat, as approved by the Engineer. Augers should be kept approximately one-half to three-quarters full of mixture at all times during the paving operation.

(d) When the asphaltic mixture is placed in a narrow strip along the edge of an existing pavement, or used to level up small areas of an existing pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated when authorized by the Engineer.

(e) Adjacent to flush curbs, gutters and structures, the surface shall be finished uniformly high so that when compacted, it will be slightly above the edge of the curb or structure.

(f) Construction joints of successive courses of asphaltic material shall be offset at least 6 inches [152 mm]. Construction joints on surface courses shall coincide with lane lines, or as directed by the Engineer.

(g) If a pattern of surface irregularities or segregation is detected, the Contractor shall make an investigation into the causes and immediately take the necessary action. With the approval of the Inspector, placement may continue for no more than one full production day from the time the Contractor is first notified and while corrective actions are being taken. If the problem still exists after that time, paving shall cease until the Contractor further investigates the causes and the Engineer approves further corrective action to be taken.

(5) Compacting.

(a) The pavement shall be compacted thoroughly and uniformly with the necessary rollers to obtain the compaction and cross section of the finished paving mixture meeting the requirements of the plans and specifications.

(b) When rolling with the three-wheel, tandem or vibratory rollers, rolling shall start by first rolling the joint with the adjacent pavement and then continue by rolling longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least 1 foot (305 mm), unless otherwise directed by the Engineer. Alternate trips of the roller shall be slightly different in length. On super-elevated curves, rolling shall begin at the low side and progress toward the high side, unless otherwise directed by the Inspector.

When rolling with vibratory steel-wheel rollers, equipment operation shall be in accordance with Item 217 "Rolling (Vibratory)", and the manufacturer's recommendations, unless otherwise directed by the

Engineer. Vibratory rollers shall not be left vibrating while not rolling or when changing directions. Unless otherwise shown on the plans or approved by the Engineer, vibratory rollers shall not be allowed in the vibrating mode on mats with a plan depth of less than 1-1/2 inches [38 mm].

The motion of the rollers shall be slow enough to avoid other than usual initial displacement of the mixture. If any displacement occurs, it s hall be corrected to the satisfaction of the Inspector. The roller shall not be allowed to stand on pavement which has not been fully compacted. To prevent adhesion of the surface mixture to the steel-wheel rollers, the wheels shall be kept thoroughly moistened with water, but an excess of water will not be permitted. Necessary precautions shall be taken to prevent the dropping of diesel, gasoline, oil, grease or other foreign matter on the pavement, either when the rollers are in operation or when standing.

(c) The edges of the pavement along curbs, headers and similar structures, and all places not accessible to the roller, or in such positions as will not allow thorough compaction with the rollers, shall be thoroughly compacted with lightly oiled tamps.

(d) Rolling with a trench roller will be required on widened areas, in trenches and other limited areas where satisfactory compaction cannot be obtained with the approved rollers.

(6) In-Place Compaction Control. In-place compaction control is required for all mixtures.

(a) Ordinary Compaction Control. One (1) three-wheel roller, one (1) pneumatic-tire roller, and one (1) tandem roller shall be furnished for each compaction operation except as provided below or approved by the Engineer. The use of a tandem roller may be waived by the Engineer when the surface is already adequately smooth and further steel-wheel rolling is shown to be ineffective. With approval of the Engineer, the Contractor may substitute a vibratory roller for the three-wheel roller and/or the tandem roller. Use of at least one (1) pneumatic -tire roller is required. Additional or heavier rollers shall be furnished if required by the Engineer.

Rolling patterns shall be established by the Contractor to achieve the maximum compaction. The selected rolling pattern shall be followed unless changes in the mixture or placement conditions occur which affect compaction. When changes in the mixture or placement conditions occur, a new rolling pattern shall be established.

(b) Compaction Cessation Temperature. Regardless of the method required for in-place compaction control, all rolling for compaction shall be completed before the mixture temperature drops below 175° F [79 °C].

(7) Opening to Traffic. If the surface ravels, flushes, ruts or deteriorates in any manner prior to final acceptance of the work, it will be the Contractor's responsibility to correct this condition at his expense, to the satisfaction of the Inspector and in conformance with the requirements of this specification.

MEASUREMENT: Hot Mix Asphaltic Concrete Pavement shall be measured by square yard (squar meter), complete in place, for the thickness specified on the plans. Limits of paymnent will be from face of curb to face of curb.. Pavement area shall not exceed the limits shown an the plans without written authorization..

PAYMENT: The work performed and materials furnished, as prescribed by this item, measured as provided herein, shall be paid for at the contract unit bid price per square yard (squar meter), complete in place, for the thickness specified on the plans of "Hot Mix Asphaltic Concrete Pavement", which price shall be full compensation for furnishing and placing all materials, and for all labor, tools, equipment, and incidentals necessary to complete the work. Prime Coat and Tack Coat, when required, shall be paid under the provisions of Item Nos. 202 and 203 respectively.

BID ITEMS:

Item 205.1 - Hot Mix Asphaltic Pavement Type "B" - _____inches[mm] pavement thickness.

Item 205.2 - Hot Mix Asphaltic Pavement Type "C" - __inches[mm] pavement thickness.

Item 205.3: Hot Mix Asphaltic Pavement Type "D" - __inches[mm] pavement thickness..

ITEM 206
ASPHALT TREATED BASE

This item shall govern for the mixture of flexible base and asphaltic material mixed hot in a mixing plant. The mixture shall be in the proportions as directed by the Engineer. The asphalt treated base shall be constructed on an approved subgrade, as herein specified and in accordance with details shown on the plans.

MATERIALS:

(1) Flexible Base: Flexible base shall conform to the requirements of Item No. 247, "Flexible Base" of the Texas Department of Transportation Standard Specifications. Type of material shall be Type "A", Grade 1.

(2) Asphaltic Material: Asphalt for the mixture shall be of the type determined by the Engineer and shall meet the requirements of Item No. 300, "Asphalt, Oils and Emulsions" of the Texas Department of Transportation Standard Specifications.

(3) Tack Coat: All tack coat shall conform to the provisions of Item No. 203, "Tack Coat".

(4) Paving Mixture: The paving mixture shall consist of a uniform mixture of mineral aggregate and asphaltic material. It shall be proportioned as directed by the Engineer after design tests have been made for the mineral aggregate approved for the project. The asphaltic material shall be of the type and grade as directed by the Engineer. Asphaltic material shall be between 4.0 and 9.0 percent of the mixture by weight, the exact amount to be determined by the test design mixture. The asphaltic material shall not vary from that proportion designated by more than 0.5 percent dry weight based upon the total mixture.

EQUIPMENT:

(1) Mixing Plants: Mixing plants that will not consistently produce a paving mixture meeting all the requirements of this specification will be condemned. Mixing plants may be of the weight-batching type, the continuous mixing type or the dryer-drum type meeting all the requirements of Item No. 345, "Asphalt Stabilized Base (Plant Mix)" of the Texas Department of Transportation Standard Specifications and subsequent revisions and Special Provisions thereto.

(2) Asphalt Material Heating Equipment: Asphalt material heating equipment shall conform to Paragraph 345.4(3) of Item No. 345, "Asphalt Stabilized Base (Plant Mix)" of the Texas Department of Transportation Standard Specifications and subsequent revisions and Special Provisions thereto.

(3) Spreading and Finishing Machine: The spreading and finishing machine shall be equipped with a heated compacting screed, and shall be capable of producing a surface that will be smooth and true to the established line, grade and cross section and acceptable to the Engineer. Unacceptable finish shall be corrected by the addition of mixture placed and finished at the entire expense of the Contractor.

CONSTRUCTION METHODS:

Refer to Item 205: "Hot Mix Asphaltic Concrete Pavement" for Construction Methods.

(1) In Place Density: It is the intent of this specification that the material be placed and compacted to a density of 95 to 100 percent of that density developed in the laboratory test method for molding stability specimens (TXDOT Test Method Tex-206-5.) Sufficient density tests will be made in order to determine that the compaction procedure used by the Contractor is adequate and proper to accomplish the intent as stated above.

The field specimens utilized for the in place density testing may be either cores or sections of asphalt-treated base. Other methods of determining in place density which correlate satisfactorily with those results obtained through use of TXDOT Test Method Tex 207-F may be used.

(2) Protection of the work: Sections of the newly finished base course shall be cleaned prior to laying the surface course or additional base courses.

MEASUREMENT:

"Asphalt Treated Base" shall be measured by the square yard [squar meter], complete in place, for the thickness specified on the plans. Limits of paymnent will be 1 foot [305 mm] beyond the back of curb.

PAYMENT: The work performed and materials furnished, as prescribed by this item measured as provided herein, shall be paid for at the contract unit price bid per square yard [square meter] for "Asphalt Treated Base", which price shall be full compensation for furnishing, hauling, and placing all materials; and for labor, tools, equipment, and incidentals necessary to complete the work, except tack coat, when required.

BID ITEM:

Item 206 - Asphalt Treated Base - ____inches [mm] compacted depth (per square yard) [square meter].

ITEM 207
SINGLE COURSE BITUMINOUS SLURRY SEAL

This item shall govern for the installation of a bituminous slurry surface consisting of properly proportioned and mixed mineral aggregate, asphalt emulsion and water, spread evenly on a pavement surface, as specified herein and as directed by the Engineer. The slurry, when cured, shall bare a homogenous appearance, fill all cracks, and adhere firmly to the adjacent surface, and have a skid resistant texture.

APPLICABLE SPECIFICATIONS:

The following specifications as to methods and materials form a part of this overall specification to the extent indicated by specific references thereto:

AASHTO - American Association of State Highway and Transportation Officials.

ASTM - American Society of Testing Materials.

TEST METHODS FOR AGGREGATE AND MINERAL FILLER:

AASHTO T2 ASTM D75 Sampling stone, slag, gravel, sand stone block for use as highway materials.

AASHTO T27 ASTM C136 Sieve Analysis of fine or course aggregate.

AASHTO T11 ASTM C117 Amount of material finer than No. 200 sieve in aggregate.

AASHTO T176 ASTM D2419 Plastic fines in graded aggregates and soils by use of the Sand Equivalent Test.

AASHTO T84 ASTM C128 Specific gravity and absorption of fine aggregate.

AASHTO T19 ASTM C29 Unit weight of aggregate.

AASHTO T96 ASTM C131 Abrasion of coarse aggregate, by use the Los Angeles Machine.

AASHTO T127 ASTM C183 Sampling Hydraulic Cement.

AASHTO T37 ASTM D546 Sieve Analysis of Mineral Filler.

TEST METHODS FOR ASPHALT EMULSIONS:

AASHTO T40 ASTM D140 Sampling Bituminous Materials.

AASHTO T59 ASTM D244 Testing Emulsified Asphalt.

TEST METHODS FOR BITUMINOUS SLURRY SURFACES:

AASHTO T164 ASTM D2172 Bitumen Content of Paving Mixture by Centrifuge.

AASHTO T30 Mechanical Analysis of Extracted.

SPECIFICATIONS FOR MINERAL FILLERS:

AASHTOM17 ASTM D242 Mineral filler for Bituminous Paving Mixtures.

SPECIFICATIONS FOR ASPHALT EMULSIONS:

AASHTO M140 ASTM D977 Specifications for Anionic Emulsified Asphalt.

AASHTO M208 ASTM D2397 Specifications for Cationic Emulsified Asphalt.

MATERIALS:

(1) ASPHALT EMULSION. The emulsified asphalt shall conform to the requirement of AASHTO M140. The emulsion shall be SS - 1h with a 4% Latex additive milled into the emulsion by the emulsion manufacturer. All shipments of latex modified emulsion shall be accompanied by a shipping ticket and a certificate of compliance which shall be given to the Inspector. Specification for type SS - 1h with the residual asphalt having a penetration of 40 - 90 and shall constitute at least 60% of the emulsion by weight, and the Saybolt Furol Viscosity of the emulsion at 77° F [25 °C] shall not exceed 50 seconds.

(2) AGGREGATE: The mineral aggregate shall consist of sound and durable 100% trap rock, and shall be free from dirt, organic matter, clay balls, adherent films of clay, dust or other objectionable matter. The aggregate shall contain no free water. When tested in accordance with AASHTO T176 or ASTM D2419, the aggregate shall have a sand equivalent of not less than 45. Mineral fillers such as portland cement, limestone dust, lime, and others shall be considered as part of the blended aggregate, and shall be used in the minimum amount required. (The use of fly ash will not be permitted.) The aggregate shall meet the gradation requirements of AASHTO M 17 or ASTM D242. Mineral fillers shall be used for one or more of the following reasons only: to improve the gradation of the aggregate; to control the time of break of the emulsions; to provide improved stability and workability of the slurry; or to increase the durability of the cured slurry. The total aggregate, including mineral filler, shall conform to the following gradation when tested by AASHTO T27 or ASTM C136:

SIEVE SIZE	PERCENT PASSING
3/8"	100
No. 4	90-98
No. 8	65-90
No. 16	45-70
No. 30	30-50
No. 50	18-30
No. 100	10-21
No. 200	5-15

PURE ASPHALT REQUIRED, % OF DRY WEIGHT OF AGGREGATE:
10.0 - 13.5

(3) WATER: All water used in making the slurry shall be potable and free of dissolved ingredients that may prove harmful. The effect of moisture content on the specific weight of the aggregate, and the moisture content of the aggregate being used, shall be taken into account in setting the machine to deliver asphalt in the correct proportion.

(4) LABORATORY TESTING: From sources selected in advance, representative samples of essential materials, taken as indicated under applicable specifications, shall be evaluated in a qualified laboratory (at no cost to the City) as to their suitability for use in slurries. Laboratory results, including evidence that the materials are acceptable, the quantitative effects of moisture content on the specific weight of the aggregate (bulking effect), a determination if mineral filler is required and in what proportion, the optimum proportions of aggregate, asphalt and prewetting water, and durability test on cured specimens shall be reported through the Contractor to the Engineer. This report shall be a written document from the laboratory to the Contractor.

(5) STOCKPILING OF AGGREGATE: Precautions shall be taken to insure that stockpiles are carefully mixed just prior to use to insure uniform distribution of the moisture, and that they do not become contaminated with over-sized rock, clay, silt or excessive amounts of moisture. The stockpile shall be kept in areas that drain readily. Segregation of aggregate will not be permitted.

(6) STORAGE: The Contractor shall provide suitable storage facilities for the modified asphalt emulsion using containers equipped to prevent water from entering the modified emulsion. If necessary, suitable heat shall be provided to prevent freezing.

(7) SAMPLING: Samples of materials and of the finished slurry surface shall be furnished by the Contractor during progress of the work and as directed by the Engineer. Test reports should be obtained from the Contractor as additional materials arrive.

EQUIPMENT AND TOOLS:

All methods employed in performing the work and all equipment, tools, and machinery used for handling the material and executing any part of the work shall be subject to the approval of the Engineer before the work is started, and whenever found unsatisfactory they shall be changed and improved as required. All equipment, tools, machinery and containers used must be kept clean and maintained in a satisfactory condition.

(1) SLURRY MIXING EQUIPMENT: The slurry mixing machine shall be a continuous flow mixing unit, capable of delivering accurately predetermined proportions of aggregate, water and asphalt emulsion to a revolving spiraled multiblade mixer tank, and of discharging the thoroughly mixed product on a continuous basis. The aggregate shall be prewetted immediately prior to mixing with the emulsion. The mixing unit shall be capable of thoroughly blending all ingredients together without violent action. The mixing machine shall be equipped with an approved fines feeder that provides an accurate metering device or method of introducing a predetermined proportion of mineral filler into the mixer as the aggregate is fed in. The fines feeder shall be used when mineral filler is a part of the aggregate blend. The mixing machine shall be equipped with a water pressure system and fog type spraybar adequate for completely fogging the surface with up to 0.05 gallons per square yard [0.2 liter per square meter], immediately ahead of the spreading equipment. The machine shall be capable of mixing materials at pre-set proportions regardless of speed of machine engine and without changing machine settings.

(2) SLURRY SPREADING EQUIPMENT: Attached to the mixer machine shall be a mechanical type squeegee distributor equipped with flexible material in contact with the surface to prevent loss of slurry from the distributor. It shall be maintained to

prevent loss of slurry on varying grades and crown by adjustments to assure uniform spread. There shall be a lateral control device and a flexible strike-off capable of being adjusted to lay the slurry at the specified rates of application. The spreader box shall have an adjustable width. The box shall be kept clean, and built-up asphalt and aggregate on the box shall not be permitted. The use of burlap drags or other drags shall be approved by the Engineer.

(3) CLEANING EQUIPMENT: Power brooms and blowers, air compressors, vacuum sweepers, water flushing equipment, and hand brooms shall be suitable for cleaning the pavement surface and cracks therein.

(4) AUXILIARY EQUIPMENT: Hand squeegees, shovels and other equipment shall be provided as necessary to perform the work.

PREPARATION OF SURFACE:

Prior to placing the slurry seal coat, the surface of the pavement shall be clean and free from dust, dirt or other loose foreign matter, grease, oil, or any type of objectionable surface film. All vegetation must be completely destroyed by a chemical weed killer before the slurry is applied. When directed by the Inspector, the existing surface shall be swept with hand brooms or power sweepers or cleaned with a power blower. When required, the pavement shall be flushed with pressure streams of water.

Water flushing will not be permitted in areas where considerable cracks are present in the pavement surface. Application of the slurry should not be started until all puddles of water have either evaporated to dryness or removed. It may be necessary to clean the pavement with a strong caustic solution, in which case the residue from this treatment shall be flushed and washed with pressure streams of water taking extreme care that all caustic is removed from the surface. The Inspector shall give final approval that the surface has been prepared properly.

The Contractor shall cover all raised pavement markers in a manner to protect and insure the integrity of the markers prior to placing the slurry seal and shall remove such covers after the completion of slurry sealing so that the markers will remain fully functional. Any markers damaged by the Contractor's operations shall be repaired or replaced at no cost to the City.

COMPOSITION AND RATE OF APPLICATION OF THE SLURRY MIX:

The amount of modified asphalt emulsion to be blended with the aggregate shall be that as determined by the laboratory and subject to final adjustment in the field to allow for absorption by the existing surface. The amount of water added must be controlled accurately to insure production of a readily spreadable, yet completely stable slurry.

Proper water content shall be determined by an appropriate consistency test on freshly made slurry.

The slurry shall be a homogenous mixture, sufficiently stable during the entire mixing-spreading period. During this period, the emulsion shall not break, no segregation of the fines from the coarser aggregate shall occur, and the liquid portion of the mix shall not float to the surface. Total time of mixing from introduction of emulsion to spreading shall be 2 minutes or less. The weight of slurry aggregate applied per unit area shall be between 10 and 15 pounds per square yard (6kg -8kg per square meter). The Engineer shall give final approval of the mixture proportions and of the thickness of application.

WEATHER LIMITATIONS:

The modified asphalt emulsion slurry treatment shall be placed only when the temperature of the pavement surface is 80° F [27 °C] or above. No slurry shall be applied under the following conditions:

(a.) While puddles of water remain on the pavement surface to be sealed.
(b.) When the weather is foggy.
(c.) If there is a chance of rain before it can be cured properly.

Slurries that cure by evaporation should not be laid during periods of abnormally high humidity.

Any uncured slurry that is washed away from the roadway by rain or other water sources into yards, driveways, sidewalks, parkways, etc., shall be removed and cleaned by the Contractor at his expense. Open or underground drainage systems shall be removed and cleaned as directed by the Engineer at the Contractor's expense.

TRAFFIC CONTROL:

It shall be the Contractor's responsibility to provide adequate traffic control measures, such as barricades, flagman, cones, etc., to protect the uncured slurry surface from all types of traffic and provide traffic safety in the construction area. Advance warning signs and barricades will be necessary. These measures shall be in accordance with the "Texas Manual on Uniform Traffic Control Devices for Streets and Highways". In the field, the Traffic Engineer will designate street closure and placement of barricades.

APPLICATION OF THE SLURRY SEAL:

1. GENERAL

The surface shall be fogged with water directly preceding the spreader. The slurry mixture shall be of the desired consistency as it leaves the mixer and no additional elements shall be added. No lumping, balling, or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate will be permitted.

If the coarse aggregate settles to the bottom of the mix, the slurry will be removed from the pavement. Care shall be taken not to overload the spreader box, which shall be towed at a slow and uniform rate not to exceed 5 miles per hour [8 kilometers per hour]. The action of the squeegee in the spreader box shall permit free flow of the slurry into all surface voids and cracks. A sufficient amount of slurry seal shall be fed to the box to keep a full supply against the full width of the squeegee. The mixture shall not be permitted to overflow the front sides of the spreader box. Adjacent lanes shall be lapped at the edges a minimum dimension which will provide complete sealing at the overlap.

The fresh mix shall be protected by barricades and markers to permit drying. In areas where the spreader box cannot be used, the slurry shall be applied by means of hand squeegees. Any joints or cracks that are not filled by the slurry mixture shall be corrected by use of hand squeegees. Upon completion of the work, the slurry seal shall have no holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement. The finished surface shall present a uniform and skid resistant appearance satisfactory to the Engineer. All wasted and unused material and all debris shall be removed from the site prior to final acceptance.

2. JOINTS:
No excessive build-up nor unsightly appearance shall be permitted on longitudinal or transverse joints. The use of burlap drags or other type drags shall be at the discretion of the Engineer. When drags are used, they must be kept relatively clean and free of excessive build-up.

3. INLET GRATES:
Before slurry seal is applied, all inlet grates or any grate opening must be covered with removable plywood.

4. HAND WORK:
Approved squeegees shall be used to spread slurry in areas not accessible to the slurry mixer. Care shall be exercised in leaving no unsightly appearance from hand work.

5. CURING:
All traffic shall be kept off the slurry seal until it has cured to a firm condition that will prevent pick-up of the mixture. If any uncured slurry is damaged or marked by a motorized vehicle, person, animal, bicycle, etc., that area will be repaired satisfactory to the Inspector at the Contractor's expense. The Contractor must plan the application of slurry so that it is cured, barricades removed and all streets open to traffic every day by 6:00 p.m.

6. LINE:
Material laid at all beginning and ending locations as shown on the plans shall be laid in a straight uniform appearing line.

7. CURBING:
The material must be placed against the curb to the thickness as specified. This is to provide a water tight seal at the gutter. All excess material in the gutters shall be removed or squeegeed back onto the roadway surface. Material lapped or splashed onto any part of the curb must be removed as soon as the material on the road has cured.

8. TEST STRIP:
After the successful bidder has the slurry seal ingredients approved by the Engineer, a test strip will be laid (location to be determined by the Engineer) before the designated job can begin. The Engineer will observe the test strip according to the specifications for a time period of 2 to 4 hours. The job may proceed after his approval. The square yards [square meter] of the test strip will be measured and paid for at the contract unit price per square yard [square meter].

NOTIFICATION:

It shall be the Contractor's responsibility to notify all residents adjacent to the project of slurry seal operations and schedules. The City will provide printed notification material to the Contractor for his distribution to the effected citizens.

MEASUREMENT AND PAYMENT:

The work performed as prescribed by this item shall be measured and paid for at the contract unit price bid per square yard [square meter] complete in place of accepted slurry seal which price shall be full compensation for furnishing and placing all materials, surface preparation, and all labor, tools, equipment and incidentals necessary to complete the work.

BID ITEM:

Item 207 - Single Course Bituminous Slurry Seal- per square yard [square meter]

ITEM 208
SALVAGING, HAULING & STOCKPILING RECLAIMABLE ASPHALTIC PAVEMENT

This item shall govern for milling the existing asphaltic concrete pavement to a prescribed depth and the removal and disposal or stockpiling of the scarified materials in accordance with the plans, or as designated by the Engineer. The planed surface shall provide a smooth surface free from gouges, continuous grooves, ridges, oil film, and other imperfections of workmanship and shall have a uniform textured appearance.

EQUIPMENT: The equipment for removing the pavement surface shall be a power operated, track propelled planing machine or grinder capable of removing, in one pass, a combined thickness of two inches [50 mm] of asphaltic concrete pavement and one-half inch [13 mm] of portland cement concrete pavement or a single thickness of four inches [102 mm] of asphaltic concrete pavement or one inch [25 mm] of portland cement concrete pavement in a minimum six-foot width [1.8 m]. The equipment shall be self-propelled with sufficient power, traction, and stability to maintain accurate depth of cut and slope. The equipment shall be capable of accurately and automatically establishing profile grades along each edge of the machine by referencing from the existing pavement by means of a ski or matching shoe or from an independent grade control and shall have an automatic system for controlling cross-slope at the rate shown on the plans.

The machine shall be equipped with an integral loading and reclaiming means to immediately remove material being cut from the surface of the roadway and discharge the cuttings into a truck in a single operation. Adequate back-up equipment (mechanical street sweepers, loaders, water truck, etc.) and adequate personnel will be provided to insure that all cuttings are removed from street surface daily. Stockpiling of planed material will not be permitted on the project site unless indicated on the plans. The machine shall be equipped with means to control dust created by the cutting action and shall have a manual system providing for uniformly varying the depth of cut while the machine is in motion thereby making it possible to cut flush to all inlets, manholes, or other obstructions within the paved area.

CONSTRUCTION METHODS: The pavement surface shall be removed to the depth, width, grade, and cross section as shown on the plans, or as directed by the Engineer. Unless shown on the plans, the existing asphaltic material shall be removed and broken up so that 100% will pass a two inch sieve. Any pavement dmaged or broken outside of established lines shall be replaced at the contractor's expense.

The Engineer may require that the pavement planing operation be referenced from an independent grade control in those areas where he deems this type of control to be appropriate. For this type of operation, the independent grade control shall be established and maintained by the Contractor in a manner acceptable to the Engineer, and the final position of same shall be acceptable to the Engineer.

The stockpile area shall be kept clean of trash, weeds, and grass and shall be relatively smooth and well drained. Silt fencing around stockpile areas shall be provided in accordance with Item 542, "Temporary Sediment Control Fence". Work performed under this item shall be prosecuted in such a manner as to cause minimum inconvenience to traffic or to the owners of adjacent property.

When located within four inches [102 mm] of steep curbs, water valves, draw grates, bridge joints, etc., asphaltic concrete that cannot be removed by the planing machine shall be removed by other methods acceptable to the Inspector and the pavement and curb surfaces shall be cleaned of all debris and left in a neat and presentable condition.

The loose material resulting from the operation shall become the property of the contractor and shall be disposed of properly. If the material is designated to remain the property of the City, it shall be as stockpiled by the contractor at locations as shown on the plans. Placement of salvaged material in stockpiles shall conform to the dimensions and requirements designated by the Inspector.

MEASUREMENT: Measurement under this bid item shall include removal of asphaltic concrete pavement by the cubic yard [cubic meter] (loose vehicle measurement) of material, or by the square yard [square meter] in its original position at a depth as shown on theplans..

PAYMENT: The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per cubic yard [cubic meter] for "Salvaging, Hauling and Stockpiling Reclaimable Asphaltic Pavement" or at the Unit price bid per square yard [square meter] for "Salvaging, Hauling and Stockpiling Reclaimable Asphaltic Pavement" of the depth specified. This price shall be full compensation for cleaning and removing existing pavement; for any necessary stockpile area preparation; for loading, crushing or breaking, hauling and stockpiling of the material; and for furnishing all materials, labor, tools, equipment, supplies and all incidentals necessary to satisfactorily complete the work.

When plans call for the installation of silt fencing protection around stockpile areas, the fencing will be measured and paid for under Item No. 542.

BID ITEM.

Item 208.1 - Salvaging, Hauling, and Stockpiling Reclaimable Asphaltic Pavement (__inches [mm] depth) - per square yard [square meter].

Item 208.2 - Salvaging, Hauling, and Stockpiling Reclaimable Asphaltic Pavement - per cubic yard [cubic meter] (loose vehicle measurement).

ITEM 209
CONCRETE PAVEMENT

This item shall govern for the installation of Portland Cement Concrete, with reinforcement as shown on the plans, constructed as herein specified on the prepared subgrade and base course in conformity with the thickness and typical cross sections shown on the plans and to the lines and grades a established by the Engineer.

MATERIALS: Unless otherwise shown on the plans or required herein, all materials shall conform to the requirements of the pertinent Items as follows:

Item 300, "Portland Cement Concrete"
Item 301, "Reinforcing Steel"
Item 304, "Expansion Joint Materials"
Item 305, "Membrane Curing"
Item 307, "Concrete Structures"

except for the following:

(1) Portland Cement Concrete. Classification and mix design shall be as shown on the plans.

The Contractor shall obtain written permission from the Engineer prior to the use of Type III cement when Type III cement is not shown on the plans.

(2) Joint Sealants and Fillers. These materials shall be of the size, shape and type shown on the plans.

Unless otherwise shown on the plans, the joint sealant materials to be used shall be self leveling low modulus silicone, single component formulation.

(3) Dowels for Expansion and Contraction Joints. Dowels shall be smooth, straight steel dowels of the size and type shown on the plans and shall conform to the requirements of ASTM A615, Grade 60. The free end of dowels shall be smooth and free of burrs.

Unless otherwise shown on the plans, the entire length of each dowel shall be coated with a hot applied asphalt cement. Cut-back asphalts and emulsions shall not be used.

Unless otherwise shown on the plans, the asphalt coated end of each dowel to be used in an expansion joint shall be encased in an approved cap having an inside diameter of 1/16 inch [2mm] greater than the diameter of the dowel. The end of the cap shall be filled with a soft compressible material or shall be void in order to permit free movement of the dowel for a distance equivalent to 150 percent of the width of the joint used. The dowel caps and dowels shall be held securely in place by ties as shown on the plans, or as approved by the Inspector.

(4) Positioning and Support Devices for Reinforcement and Joint Assemblies. These devices shall be of sufficient structural quality to prevent movement of the dowels or steel reinforcement during concrete placement and finishing. Devices shall be of a type approved by the Inspector.

Positioning and supporting devices (chairs) for steel reinforcement bars shall be either plastic or metal and of sufficient number to maintain the position of the bars within the allowable tolerances.

Metal positioning and supporting devices for expansion and contraction joint assemblies (such as welded wire bar chairs, bar stakes, etc.) where used shall be as shown on the plans or may be similar devices of equivalent or greater strength, approved by the Engineer. The support devices shall secure the joint assembly and dowels within the allowable tolerances while providing no restraint against joint movement. Dowels used in joint assemblies shall be secured in parallel position by a transverse metal brace of the type and design shown on the plans, or may be secured by other devices approved by the Engineer. The devices shall provide positive mechanical connection between the brace and each unit (other than by wire tie) and prevent transverse movement of each load transmission device.

(5) Reinforcing Steel. ASTM A616 Grade 60 will be permitted for straight bars only. Reinforcing steel that requires bending shall be ASTM 615 Grade 40 with the spacing reduced to 2/3 of that shown for Grade 60 reinforcing steel. When shown on the plans, corrosion protection shall be applied to dowels and tie bars.

(a) Tie Bars. Tie bars at weakened plane longitudinal joints shall be straight reinforcing bars. Tie bars at longitudinal construction joints shall be either multiple piece tie bars or straight reinforcing bars, when

equipment or conditions permit. Bent reinforcing bars may be used for longitudinal construction joints unless otherwise shown on the plans.

(b) Multiple Piece Tie Bars. Multiple piece tie bars (threaded coupling or other adequate devices) shall develop a tensile strength over their entire length equal to 1 /4 times the yield strength of the tie bars shown. Each end of multiple piece tie bars shall consist of deformed reinforcement of at least the size shown on the plans, conforming to Item 440, "Reinforcing Steel". The deformed portion of each end of multiple piece tie bars shall be at least 1/2 of the length of the tie bars shown on the plans. Unless otherwise shown on the plans, the spacing for multiple piece tie bars shall be equal to or less than that of the transverse bars shown.

(6) Curing Materials. Curing material shall conform to Type 2 Class A curing compound or emulsified asphalt of the type and grade as shown on the plans.

EQUIPMENT:

(1) General. All equipment shall be maintained in good condition and approved by the Inspector before the Contractor will be permitted to begin construction of the pavement.

(2) Grade Control Equipment. When concrete pavement is not formed, equipment used in the spreading and finishing of concrete pavement shall be designed to be operated on a prepared track grade controlled by electronic sensor systems. The systems used on a prepared track grade shall operate from an adequately supported string line or equivalent system approved by the Inspector.

(3) Planers and Templates. Planers and templates shall operate on forms or use approved grade control equipment. Other methods of controlling the planer or template may be used as approved by the Engineer in writing.

(4) Forms.

(a) Side Forms. Side forms shall be of metal except a otherwise provided herein and shall be of approved cross section. The length of form sections shall not be less than 10 feet [3 m], and each section shall provide for staking in position with not less than three (3) pins. Forms shall be of ample strength and shall be provided with adequate devices to secure them in place so the forms will withstand, without visible springing or settlement, the impact and vibration of the spreading and finishing machinery. In no case shall the base of the form be less than 8-inches [203 mm] wide for a form depth of 8-inches [203 mm] or more in height. The forms shall be free from warps, bends or kinks, and shall be sufficiently true to provide a reasonably straight edge on the concrete. The top of each form section, when tested with a straight edge, shall conform to the requirements specified for the surface of the completed pavement. A sufficient number of forms shall be provided for satisfactory prosecution of the work.

Flexible or curved forms of wood or metal of proper radius shall be used for curves of 100 foot [30 m] radius or less.

(5) Concrete Spreader. A mechanical concrete spreader shall conform to the following requirements.

Be a self-propelled machine having sufficient power and traction to spread and strike off concrete without slippage,

Be equipped with a power driven device, either a reciprocating blade, screw conveyor or a belt conveyor, for spreading the concrete uniformly, and be capable of striking off the concrete slab at the depth and grade required.

Mechanically-operated concrete spreaders of other designs, which uniformly distribute the concrete with minimal segregation, may be used when approved by the Inspector in writing.

(6) Slipform Paver. Slipform pavers shall be equipped to spread the concrete uniformly and strike off the concrete to the required section, using a power driven device, either a reciprocating blade, a screw conveyor, or a belt conveyor, without loss of traction.

The slipform paver shall have an electronic sensor system or equivalent to provide grade control for the paver, unless otherwise shown on the plans.

The slipform paver shall be equipped with consolidation equipment.

(7) Floats. Floats shall be either mechanically operated oscillating longitudinal floats or tube floats capable of producing a uniformly smooth surface.

Tube floats shall be designed to operate at an angle of greater than 30 degrees from normal when rotated either direction. The tube float shall extend across the pavement to the side forms and/or the edge of the concrete pavement. The tube float shall be equipped to provide a fine light fog mist.

(8) Mechanical Vibratory Equipment. Mechanical vibrating equipment shall conform to the following:

(a) Immersion (Internal) Vibrators. Immersion vibrators shall be spaced at not more than 24 inches [610 mm] and shall be equipped with synchronized vibratory units. Separate vibratory units shall be spaced at sufficiently close intervals to provide uniform vibration and consolidation to the entire depth and width of the pavement. The frequency in air of the immersion vibrator units shall be not less than 8,000

cycles per minute. The Contractor shall have a satisfactory tachometer available for checking the vibratory elements.

(b) Hand Operated Immersion Vibrators. Approved hand operated immersion vibrators shall be furnished in sufficient number for proper consolidation of the concrete along forms, at joints and in areas not covered by mechanically controlled vibrators. These vibrators shall be sufficiently rigid to insure control of the operation position of the vibrating head.

(c) Pan (Surface) Vibrators. Pan vibrators shall apply vibration directly to the surface of the concrete. The operating frequency shall be not less than 3,500 cycles, nor more than 4,200 cycles per minute in air. The Contractor shall have a satisfactory tachometer available for checking the speed of the vibratory elements.

(9) Finishing Equipment.

(a) Finishing Machine. The transverse finishing machine shall have two (2) screeds accurately adjusted to the crown of the pavement finishing machine. The transverse finishing machine shall be capable of striking off and consolidating the concrete. It shall be equipped with consolidation equipment, and shall be self-propelled and mounted in a substantial frame equipped to ride on the forms, or may be a slipform finisher.

(b) Manually Operated Finishing Screed. A manually operated finishing screed shall be a strike template and a tamping template or a vibratory screed at least 2-feet [610 mm] longer than the width of the pavement.

Both templates shall be capable of conforming to the crown of the pavement.

(10) Texturing Equipment. Texturing equipment shall consist of the following:

(a) Carpet Drag. Carpet drag shall be mounted on a work bridge or a movable support system capable of varying the area of carpet in contact with the pavement. The carpet drag shall be a single piece of carpet long enough to span the full width of the pavement being placed and adjustable so as to have up to a 4 foot longitudinal length of carpet in contact with the concrete being placed. The carpeting used shall be an artificial grass type having a molded polyethylene pile face with a blade length of 5/8 inch to 1 inch [16 mm - 25 mm] and a minimum weight of 70 ounces per square yard [1.9 kilograms per square meter]. The backing shall be a strong, durable material not subject to rot, and shall be adequately bonded to the facing to withstand use as specified.

(b) Transverse Metal Tining Device. The transverse metal tine device shall be mechanized and be equipped with four 4 inch to 6 inch [102 mm to 152 mm] steel tines, spaced nominally at one (1) inch [12 mm], center to center, approximately 0.032 inch by 0.083 inch [01 mm to 3 mm] (tine cross section), adjustable so as to obtain randomized grooves approximately 3/16 inch [5 mm] deep, with a minimum depth of 1/8 inch [3 mm].

The texturing equipment shall be operated independent from the spreading, finishing and curing equipment and from the curing operation. Hand operated texturing equipment may be approved by the Engineer for use on small or irregular shaped areas, provided an equivalent texture is obtained.

QUALITY OF CONCRETE.

The quality of concrete shall be in accordance with Item 300, "Portland Cement Concrete", and the additional requirements herein.

Appropriate changes in the mix design shall be made when the average seven (7) day flexural strength of the concrete, as indicated by the last 10 flexural strength values (modulus of rupture) obtained from tests of beams made from concrete of the same water-cement ratio, departs from the desired minimum average strength more than four (4) percent.

Unless otherwise shown on the plans, the contractor will be responsible for the testing of beams for flexural strength which will be prepared and tested in accordance with Test Method Tex-448-A. Beam and/or cylinder forms shall conform to the requirements of Test Method Tex-448-A.

Additional flexural strength test specimens may be made as required by concrete placing conditions or for adequately determining the strength of the concrete where the early opening of the pavement to traffic is dependent upon concrete strength tests. The flexural strength test is for process control and not for acceptance or rejection of concrete pavement. For early opening to traffic, the flexural strength specimens shall be cured at the same time and in the same manner as the pavement,

SUBGRADE, SUBBASE AND FORMS:

(1) Preparation of Subgrade or Subbase. The concrete pavement shall be constructed on a prepared surface, either subgrade, unstabilized subbase or stabilized subbase as shown on the plans.

The roadbed shall be completed to the plane of the typical sections shown on the plans and the lines and grades established by the Engineer. Drainage of the roadbed shall be maintained at all times.

The subgrade or unstabilized subbase shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the pavement is placed and shall be kept thoroughly wetted sufficiently in advance of placing any pavement. When it is necessary to operate equipment on the prepared subgrade, all damage to the prepared subgrade shall be corrected by the Contractor at the Contractor's expense.

(2) Placing and Removing Forms. The subgrade under the forms shall be firm and cut to grade so that each form section when placed is firmly in contact with the subgrade for its whole length and base width.

Forms shall be staked with at least three (3) pins for each 10-foot [3 m] section. A pin shall be placed at each side of every joint. Form sections shall be tightly joined and keyed to prevent relative displacement. Forms shall be cleaned and oiled prior to each use.

Side forms shall be set for a sufficient distance in advance of the point where concrete is being placed to permit a finished and approved subgrade length of generally not less than 300 feet [91 m] ahead of the spreader. Conformity of the grade, alignment and stability of forms shall be checked immediately prior to placing concrete, and all necessary corrections shall be made. If forms settle and/or deflect over 1/8 inch [3 mm] under finishing operations, paving operations shall be stopped and the forms shall be reset to line and grade and the concrete surface refinished to correct grade. The Inspector may allow suitable stakes driven to the grade of the bottom of the forms to afford additional support.

Side forms shall remain in place for not less than eight (8) hours after the concrete has been placed. The forms shall be carefully removed in such a manner that minimal or no damage will be done to the edge of the pavement. All damage resulting from this operation and any honeycombed areas shall be repaired with a mortar mix within 24 hours after form removal unless otherwise approved by the Inspector.

After a bulkhead for a transverse construction joint has been removed, the joint face shall be cleaned, and any honeycombed areas repaired with mortar within 24 hours unless otherwise approved by the Engineer.

PLACEMENT OF REINFORCING STEEL AND JOINT ASSEMBLIES:

All reinforcing steel, including steel wire fabric reinforcement, tie bars, dowel bars, and load transmission devices shall be accurately placed and secured in position in accordance with Item 301, "Reinforcing Steel", and the additional requirements herein and details and the requirements shown on the plans.

The dowels shall be placed at a depth of d/2 in the pavement, and parallel to the surface and pavement edge, with a tolerance for such alignment of $\pm$ 1/4 inch [6 mm] per dowel.

Within any area bounded by 2 feet [610 mm] of pavement length measured parallel to the centerline and 12 feet [3.7 m] of pavement length measured perpendicular to the pavement centerline, not over 33 percent of the longitudinal steel shall be spliced.

Coated dowel bars shall be free of dirt or other foreign mater at the time of installation in the concrete.

(1) Manual Placements. Reinforcing bars shall be securely wired together at alternate intersections and at all splices, and shall be securely wired to each dowel intersected. When wire fabric is used, it shall be securely wired together at all splices and to each dowel and/or tie bar intersected.

(2) Mechanical Placement. Mechanical placement of reinforcing steel and tie bars will be permitted unless otherwise shown on the plans. If this method results in steel misalignment, poor concrete consolidation around the steel, or segregation of concrete or other inadequacies, the work shall be completed using manual methods.

(3) Placing Reinforcement at Joints. Where the plans require an assembly of parts at pavement joints, the assembly shall be completed, placed at the required location and elevation, and all parts rigidly secured in the required position by the methods and devices shown on the plans or by approved methods and devices equivalent thereto. Dowel bars shall be accurately installed in joint assemblies in accordance with the plans, parallel to the pavement surface and to the centerline of the pavement, and rigidly secured in the required position by such means (as shown on the plans, or approved equivalent thereto) that will prevent their displacement during placing and

finishing of the concrete. Header boards, joint filler and other material used for forming joints shall be accurately notched to receive each load transmission device. All load transmission devices and assemblies shall be substantially free of rush and clean when the concrete is placed.

CONCRETE MIXING AND PLACING:

(1) Mixing. Concrete mixing shall be in conformance with Item 300, "Portland Cement Concrete"

(2) Workability of Concrete. The concrete shall be workable, cohesive, possess satisfactory finishing qualities, and have a consistency conforming to the specified slump requirements.

(3) Placing. Unless otherwise shown on the plans, the concrete shall be placed using either forms or a slipform paver. Any concrete not placed as herein prescribed within the time limits specified will be rejected.

Temperature-Time Requirements

Concrete Temp (at point of placement)	Max Time (No Retarding Agent) Minutes	Max Time (1) (With Retarding Agent) Minutes
Above 90°F [32 °C]	45	75
Above 75° F thru 90°F [24 °C - 32 °C]	60	90
75° F [24 °C] and Below	90	120

(1) Normal dosage of retarder

The Contractor shall provide a system satisfactory to the Engineer for determining that concrete delivered to the road meets the specified requirements for mixing and time of placing.

The concrete shall be placed as near as possible to its final location and in such manner as to minimize segregation and rehandling. Where hand spreading is necessary, concrete shall be distributed to the required depth by use of shovels. The use of rakes will not be permitted.

Paving equipment and mixers shall not be located on completed pavement, except as herein provided. The paving equipment and mixer may be located and operated on completed pavement, when the concrete has aged for seven (7) curing days and provided suitable protection to the pavement is provided.

Concrete shall be placed, consolidated and finished to conform to the required section and grade.

The pavement edge shall not deviate from the established paving line by more than 1/2 inch [13 mm] at any point as shown on plans.

Unless otherwise shown on the plans or approved by the Inspector, concrete shall not be placed before sunrise and shall not be placed later than such time which will permit the completion of all finishing operations during sufficient natural light.

When concrete mixing and finishing is done in other than daylight hours, provisions shall be made to adequately light the entire placement site. The Inspector will approve the adequacy of such lighting before operations are begun.

(a) Double Strike-off Method. Unless otherwise shown on the plans, when concrete placement is accomplished in two (2) lifts (double strike-off method) to allow placing the reinforcement after the first lift, the first lift shall be uniformly spread and/or struck off so that the final position of the longitudinal steel will be within 1/2 inch [13 mm] of the position shown on the plans. The second lift shall be placed as soon as the

reinforcing steel is in place and prior to initial set of the first lift. The second lift shall not be placed later than 20 minutes after strike-off of the first lift.

(4) Consolidation. All concrete placed for pavement shall be consolidated by approved mechanical vibrators operated ahead of the finishing machine. Unless otherwise shown on the plans, pan type vibrators shall be used for double lift placement of concrete and the immersion type vibrators shall be used for full-depth placement, unless otherwise approved by the Inspector.

The vibrators shall not be operated for more than five (5) seconds while the machine upon which they are installed is standing still.

(5) Cold Weather Precautions. Except by specific written authorization of the Engineer, concrete shall not be placed when the ambient temperature is below 40° F [4 °C] and falling. Concrete may be placed when the ambient temperature is above 35° F [2 °C] and rising, the ambient temperature being taken in the shade and away from artificial heat.

The Contractor shall have available a sufficient supply of approved cotton mats, polyethylene sheeting or other approved covering materials to immediately protect concrete if the air temperature falls to 32° F, [0 °C] or below, before concrete has been in place for less than four (4) hours. Such protection shall remain in place during the period the temperature continues below 32° F [0 °C], or for a period of not more than five (5) days. Neither salt nor other chemical admixtures shall be added to the concrete to prevent freezing. The Contractor shall be responsible for the quality and strength of concrete under cold weather conditions and any concrete damaged by freezing shall be removed and replaced at the Contractor's expense.

JOINTS:

(1) General All transverse and longitudinal joints, when required in the pavement, shall be of the type or alternate type shown on the plans and shall be constructed at the required location and alignment, in relationship to the tie bars and joint assemblies, and in accordance with details shown on the plans. Stakes, braces, brackets or other devices shall be used as necessary to keep the entire joint assembly in true vertical and horizontal position. Where concrete base is overlaid by asphaltic concrete, the joints shall be prepared as specified herein, but joint sealing will not be required unless shown on the plans.

Careful workmanship shall be exercised in the construction of all joints to insure that the concrete sections are completely separated by an open joint or by the joint materials and to insure that the joints will be true to the required section.

All joints shall be sawed and sealed before placing concrete in adjacent lanes and before permitting traffic to use the pavement.

When sawed joints are used, they shall be sawed to the depth as shown on the plans as soon as sawing can be accomplished without damage to the pavement. Once sawing has commenced, it shall be continued until completed and all such sawing must be completed within 12 hours of placement. Sawing must be accomplished even in rain and cold weather.

When membrane curing is used, the part of the seal which has been disturbed by sawing operations shall be resprayed by the Contractor with additional curing compound.

(2) Expansion Joints. Transverse expansion joints shall be constructed in accordance with the details shown on the plans. After the finishing machine and before the carpet drag and tining machines have passed over the joint the Contractor shall inspect the joint filler for correctness of position.

(3) Weakened Plane Joints. Weakened plane joints shall consist of transverse contractor joints and longitudinal joints. Unless otherwise shown on the plans, the transverse joints shall be formed or sawed perpendicular to the centerline and surface of the pavement.

The joints shall be constructed in the sequence of operations, as shown on the plans.

Chalk line, string line, sawing template or other approved methods shall be used to provide a true joint alignment.

When the flex plane type longitudinal joint is used, it shall be placed behind the longitudinal float.

(4) Transverse Construction Joints. When the placing of concrete is stopped, a bulkhead of sufficient cross sectional area to prevent deflection, accurately notched to receive the load transmission devices and shaped accurately to the cross section of the pavement shall be provided.

Intentional stoppage of the placing of the concrete shall be at either an expansion joint or at a weakened plane joint, when load transmission devices are shown on the plans. When the design for load transmission does not include dowels, intentional stoppage shall be in the middle of a slab.

When an unintended stoppage of the placing of concrete occurs, the Contractor shall immediately place the available concrete to a line and install the above described bulkhead at right angles to the centerline of the pavement, perpendicular to the surface and at the required elevation. Concrete shall be placed and

finished to this bulkhead. Any concrete remaining on the subgrade ahead shall be removed and disposed of as directed by the Inspector. When placement of concrete is resumed before the concrete has set to the extent that the concrete will stand on removal of the bulkhead, the new concrete shall be consolidated with the first. The edge created by construction joints of this type shall have a joint seal space and shall be sealed as required for contraction joints.

At transverse construction joints in continuously reinforced concrete pavement, the reinforcement or load transmission device immediately beyond the joint will be protected against vibration or impact by the Contractor until paving resumes.

(5) Longitudinal Construction Joints. Longitudinal construction joints shall be of the type and at the locations shown on the plans.

(6) Joint Filler Boards. Jointfiller boards shall be of the size, shape and type as shown on the plans. Boards shall be anchored as shown on the plans.

SPREADING AND FINISHING:

(1) Machine-Finishing. All concrete pavement shall be finished with approved self-propelled machines, except as herein provided.

Machine-finishing of pavement shall include the use of power-driven spreaders, power-driven vibrators, power-driven strike-off, and screed, or such alternate equipment as may be substituted and approved.

The transverse finishing machine shall first be operated to compact and strike-off the concrete to the required section and grade, without surface voids. The machine shall be operated over each area as many times and at such intervals as needed to consolidate and shape the surface. After completion of finishing with the transverse finishing machine, a float may be used.

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When field conditions require additional moisture for the final concrete surface finishing operation, the water shall be applied to the surface by a fine, light fog mist and the amount of water added shall be held to a minimum.

Final finish shall consist of a combination of a carpet drag and metal tine finish, unless otherwise shown on the plans. Final finish shall be completed before the concrete has attained its initial set.

The final finish shall be accomplished by first drawing the specified carpet drag longitudinally along the pavement. The actual contact surface shall be regulated so that a coarse texture satisfactory to the Inspector is obtained.

Immediately following the carpet drag, the pavement surface shall be given a transverse metal-tine finish. The metal-tine device shall be operated so as to obtain randomly spaced grooves approximately 3/16 inch deep [5 mm], with minimum depth of 1/8 inch [3 mm] and approximately 0.083 inch [2 mm] wide. Successive passes of the tines shall not overlap a previous pass. Manual methods for achieving similar results may be used on irregular sections of pavement.

After completion of texturing, the edge of the slab and joints shall be carefully finished as directed by the Inspector.

Pavement which is to be overlaid under this contract will not require tine texturing, unless otherwise shown on the plans.

(2) Hand Finishing. Hand finishing will be permitted on the transition from a crowned section to a super elevated section without crown on curves, and on straight line super elevation sections less than 300 feet [91 m] in length. Hand finishing will also be permitted on that portion of a widened pavement outside the normal pavement width, on sections where the pavement width is not uniform, or on required monolithic widths greater than that of available finishing machines. Hand finishing will be allowed only in those conditions provided for above and upon other specific areas authorized by the Inspector.

CURING:

(1) General. All concrete pavement shall be cured for a period of not less than 72 hours from the beginning of curing operations. All exposed surfaces, including vertical surfaces of the placed concrete, shall be cured immediately after finishing operations have been completed, in accordance with the requirements specified herein.

Failure to maintain adequate curing shall be cause for immediate suspension of concreting operations.

The applied curing material may be removed as necessary to saw joints or to comply with the requirements for any surface test. The hardened concrete surface shall be maintained wet with a water spray, if required, and the curing material replaced immediately after completion of sawing, testing and any required surface correction.

(2) Polyethylene Film Curing. After the final finish and the concrete surface has attained initial set, the concrete surface shall be wetted with water, applied in the form of a fine spray and covered with the polyethylene film so placed and weighted as to remain in direct contact with the surface. The polyethylene film blanket shall be maintained in place continuously for not less than the specified curing period.

All joints shall be sealed in a manner acceptable to the Inspector to provide a moisture-proof lap.

The polyethylene film blankets shall be adequately weighted to prevent displacement or billowing due to wind and the film folded down over the side of the pavement shall be secured by a continuous bank of earth or other approved material. Plowing of this windrow into place will not be permitted.

All tears or holes appearing in the polyethylene film during the curing period shall be immediately repaired by placing acceptable moisture proof patches over such defects or by replacing the blankets. It shall be the Contractor's responsibility to prevent damage to the film blankets which would affect their serviceability and effectiveness as a concrete curing method. Blankets may be rejected at any time when, in the opinion of the Inspector, they do not provide an airtight covering.

Polyethylene film blankets rejected because of pinholes or minor tears may be continued in service when repaired to an airtight condition.

(3) Membrane Curing. After final finish and immediately after the free surface moisture has disappeared, the concrete surface shall be sprayed uniformly with a curing compound in accordance with Item 305. Should the membrane be damaged from any cause before the expiration of 72 hours after original application, the damaged portions shall be repaired immediately with additional compound.

Special care shall be taken to insure that the sides of the tining grooves are coated with the curing compound.

PROTECTION OF PAVEMENT AND OPENING TO TRAFFIC:

(1) Protection of Pavement. The Contractor shall erect and maintain the barricades, shown on the plans, and such other standard and approved devices that will exclude all vehicles and/or equipment from the newly placed pavement for the periods of time specified herein. During the period prior to opening to traffic as herein specified, crossings of the pavement required by the plans, or by construction sequence shall be accomplished through the use of an adequate and substantial bridge or other protection, as approved by the Engineer.

(2) Opening Pavement to Traffic. The pavement shall be closed to all traffic, including vehicles of the Contractor, until the concrete is at least four (4) days old. This period of closure to all traffic may be extended if, in the opinion of the Engineer, weather or other conditions may require an extension of the time of protection. When Type II cement is used one (1) additional day shall be required for a total of five (5) days.

At the end of this period the pavement may be opened for use by vehicles of the Contractor provided the gross weight (vehicle plus load) of such vehicles and/or equipment does not exceed 14,000 pounds [6.3 megagrams]. On those sections of the pavement to be opened to traffic, all joints shall first be sealed and the pavement cleaned. Unless otherwise shown on the plans, stable material shall be placed against the pavement edges before permitting vehicles thereon.

After the concrete in any section of pavement is seven (7) days old, such section of pavement may be opened to all traffic as shown on the plans or as directed by the Engineer. When Type II cement is used one (1) additional day shall be required for a total of eight (8) days. For those sections of the pavement to be opened to traffic, all joints shall first be sealed, the pavement cleaned, stable material placed against the pavement edges unless otherwise shown on the plans and all other work performed as required for the safety of traffic.

(3) Emergency Opening to Traffic. The Inspector may require the opening of pavement to traffic prior to the minimum time specified above under conditions of emergency which in his opinion require such action in the interest of the public. In no case will the Inspector order opening of the pavement to traffic within 72 hours after the last concrete in the section is placed. The Contractor shall remove all obstructing materials, place stable material against the pavement edges and perform the work involved in providing for the safety of traffic as required by the Engineer in ordering emergency opening. Orders for emergency opening of the pavement to traffic will be issued in writing by the Engineer.

MEASUREMENT: Concrete Pavement will be measured by the square yard [square meter], complete in place, for the thickness specified on the plans.

PAYMENT: Concrete Pavement of the depth specified, completed and accepted will be paid for at the unit price bid per square yard [square meter], which price shall be full compensation for loading, hauling, utilizing and/or disposing of all excavated materials, for shaping and fine-grading the roadbed, including furnishing and applying all water required; for coating steel bar dowels; for furnishing all material and constructing all joints, for all reinforcing steel, and for all manipulations, labor, equipment, appliances, tools and incidentals necessary to complete the work.

BID ITEM:

Item 209 - Concrete Pavement - per square yard [square meter].

ITEM 210
ROLLING
(Flat Wheel)

This Item shall govern for the compaction of embankment, flexible base, or surface treatments, by the operation of approved power rollers as herein specified and as directed by the Inspector.

EQUIPMENT:

(1) Embankments and Flexible Bases. Power rollers shall be of the three-wheel, self-propelled type, weighing not less than 10 tons [9 megagrams] and shall provide a compression on the rear wheels of not less than 325 pounds per linear inch [5800 kilograms per linear meter] of tire width. All wheels shall be flat, the rear wheels shall have a diameter of not less than 48 inches [1.2 m], and each shall have a tire width of not less than 20 inches [508 mm].

(2) Surface Treatments. Power rollers shall be the three-wheel or tandem, self-propelled type, weighing not less than 3 tons [2.7 megagrams] nor more than 6 tons [5.4 megagrams]. All wheels shall be flat.

In lieu of the equipment specified, the Contractor may, upon written permission of the Inspector, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Inspector, its use shall be discontinued and the Contractor will be required to furnish the specified equipment.

CONSTRUCTION METHODS:

Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another that one roller unit

cannot perform the required compaction satisfactorily, additional roller units shall be provided.

(1) Embankments and Flexible Bases. The embankment layer or the base course shall be sprinkled if directed, and rolling with a power roller shall start longitudinally at the sides and proceed towards the center overlapping on successive trips by at least one-half of the width of the rear wheel of the power roller. On superelevated curves, rolling shall begin at the low sides and progress toward the high sides. Alternate trips of the roller shall be slightly different in length. Rolling shall continue until proper compaction is achieved. The rollers, unless otherwise directed, shall be operated at a speed between 2 and 3 miles per hour [3 km/h to 5 km/h].

(2) Surface Treatments. Rolling shall be done as called for in surface treatments items. The sequence of work shall be as specified for embankment layer or base course. The operating speed shall be as directed by the Inspector.

MEASUREMENT. Rolling (Flat Wheel) will not be measured for payment.

PAYMENT. The work prescribed herein will not be paid for directly, but shall be included in the unit price bid for the items of construction in which the operations occur.

ITEM 211
ROLLING
(Tamping)

This Item shall govern for the compaction of embankment or of flexible base by the operation of approved tamping rollers as herein specified and as directed by the Inspector.

EQUIPMENT: Equipment shall conform to the following requirements:

(1) It shall be a self propelled roller capable of operating in a forward or backward motion.

(2) It shall have one or more tamping drums with an effective rolling width of not less than 60 inches [1.5 m).

(3) Tamping drums shall be self cleaning.

(4) Tamping feet shall project not less than 3 inches [76 mm] from the surface of the drum.

(5) The load tamping foot shall exert a pressure of not less than 125 pounds per square inch [860 kPa] nor more than 550 pounds per square inch [3800 kPa] in a static mode.

(6) Compaction in a vibratory mode will be permitted.

(7) General. If approved by the Engineer, the Contractor may substitute rollers conforming to requirements in Item 212, "Rolling (Heavy Tamping)", in lieu of rollers specified above. Such units shall be considered a roller unit.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Inspector, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Inspector, its use shall be discontinued and the Contractor will be required to furnish the specified equipment.

CONSTRUCTION METHODS: The embankment layer or the base course shall be sprinkled if directed. Rolling with a tamping roller unit shall start longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least one-half of the width of the tamping roller unit. On superelevated curves, rolling shall begin at the low sides and progress toward the high sides. Alternative trips of the unit shall be slightly different in length. Rolling shall continue until proper compaction is achieve. The tamping roller unit, unless otherwise directed, shall be operated at a speed between 2 and 3 mile per hour [3 km/h to 5 km/h].

Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another than one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

MEASUREMENT: Rolling (Tamping) will not be measured for payment.

PAYMENT: The work prescribed herein will not be paid for directly, but shall be included in the unit price bid for the items of construction in which the operations occur.

ITEM 212
ROLLING
(Heavy Tamping)

This Item shall govern for the compaction of embankment, flexible base or other courses, by the operation of approved tamping rollers as herein specified, and as directed by the Inspector.

COMPACTION EQUIPMENT: The heavy tamping roller shall consist of two or three metal drums, rolls, or shells of 60 inches [1.5 m] minimum diameter. If the two-drum type is furnished, each drum shall be not less than 60 inches [1.5 m] in length. If the three-drum type is furnished, the roller shall consist of two forward drums and one rear drum, the drums are to be arranged so that the rear drum will compact the space between the two forward drums, and rollers of this type shall have an overall width of not less than 10 feet [3 m].

The drums shall be unit-mounted in a rigid frame in such manner that each drum may oscillate independently of the other.

Each drum shall be surmounted by metal studs with tamping feet projecting not less than 7 inches [178 mm] from the surface and shall be so spaced as to result in one tamping foot for each 0.65 to 0.70 square foot [0.06 to 0.7 square meter] of drum area. The area of each tamping foot shall be approximately 7 square inches [4500 square milimeters]. All rollers shall be provided with cleaning teeth so designed and attached as to prevent the accumulation of material between the tamping feet.

The roller shall be so designed that by ballast loading, the load on each tamping foot may be varied up to at least 550 pounds per square inch [3800 kPa] of cross-sectional area. The load per tamping foot will be determined by dividing the total weight of the roller by the number of tamping feet in one row parallel to or approximately parallel to the axis of the roller. The compression to be provided at any time shall be as directed by the Engineer.

One tamping roller, consisting of two drums or three drums, conforming to the above requirements and drawn by an approved type tractor of adequate tractive effort, shall be considered a heavy tamping roller unit.

Where turning is impractical or detrimental to the work, and when specifically directed by the Inspector, the roller shall be capable of being operated in a forward or backward motion.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Inspector, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Inspector, its use shall be discontinued and the Contractor will be required to furnish the specified equipment.

CONSTRUCTION METHODS: The embankment layer or the base course shall be sprinkled if directed. Rolling with a tamping roller unit shall start longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least one-half of the width of the tamping roller unit. On superelevated curves, rolling shall begin at the low sides and progress toward the high sides. Alternative trips of the unit shall be slightly different in length. Rolling shall continue until proper compaction is achieve. The tamping roller unit, unless otherwise directed, shall be operated at a speed between 2 and 3 mile per hour [3 km/h to 5 km/h].

Sufficient roller shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another than one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

MEASUREMENT: Rolling (Heavy Tamping) will not be measured for payment.

PAYMENT: The work prescribed herein will not be paid for directly, but shall be included in the unit price bid for the items of construction in which the operations occur.

ITEM 213
ROLLING
(Pneumatic Tire)

This Item shall govern for the compaction of embankment, flexible base, surface treatments, or pavements by the operation of approved pneumatic tire rollers as herein specified and as directed by the Inspector.

EQUIPMENT:

(1) General. When used on seal coats, asphaltic surface treatments and bituminous mixture pavements, the roller shall be self-propelled and equipped with smooth tread tires whether "Rolling (Light Pneumatic Tire)" or "Rolling (Medium Pneumatic Tire)". The roller shall be so constructed as to be capable of being operated in both a forward and a reverse direction.

When used on bituminous mixture pavements, the roller shall have suitable provisions for moistening the surface of the tires while operating.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Inspector, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Inspector, its use shall be discontinued and the Contractor will be required to furnish the specified equipment.

(2) The light pneumatic tire roller shall consist of not less than nine pneumatic tired wheels, running on axles in such manner that the rear group of tires will cover the entire gap between adjacent tires of the forward group, and mounted in a rigid frame and provided with a loading platform or body suitable for ballast loading. The front axle shall be attached to the frame in such manner that the roller may be turned within a minimum circle. The pneumatic tire roller under working conditions shall have an effective rolling width of approximately 60 inches [1.5 m] and shall be so designed that by ballast load, the total load may be varied uniformly from 9,000 pounds [4 megagrams] to 18,000 pounds [8 megagrams]. The roller shall be equipped with tires that will afford ground contact pressures of 45 pounds per square inch [310 kPa] or more. The operating load and tire air

pressure shall be within the range of the manufacturer's charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loading for the particular tires furnished. The roller under working conditions shall provide a uniform compression under all wheels. Individual tire inflation pressures shall be within plus or minus 5 psi [34 kPa] of each other. The pneumatic tire roller shall be of the self-propelled type.

(3) Medium pneumatic tire roller (Type A). It shall consist of not less than seven pneumatic tired wheels, running on axles in such manner that the rear group of tires will cover the entire gap between adjacent tires of the forward group, and mounted in a rigid frame and provided with a loading platform or body suitable for ballast loading. The front axle shall be attached to the frame in such manner that the roller may be turned within a minimum circle. The pneumatic tire roller under working conditions shall have an effective rolling width of approximately 84 inches (2 130 mm) and shall be so designed that by ballast load, the total load may be varied uniformly from 23,500 pounds (10 660 kg) to 50,000 pounds (22 680 kg). The roller shall be equipped with tires that will afford ground contact pressures to 80 pounds per square inch (552 kPa) or more. The operating load and tire air pressure shall be within the range of the manufacturer's chart. The roller under working conditions shall provide a uniform compression under all wheels. Individual tire inflation pressures shall be within plus or minus 5 psi [34 kPa] of each other.

The pneumatic tire roller shall be of the self-propelled type. The power unit shall have adequate tractive effort to properly move the operating roller at variable uniform speeds up to approximately 5 miles per hour [8 km/h].

(4) Medium pneumatic tire roller (Type B) shall conform to the requirements for Medium Pneumatic Tire Roller, Type A as specified in (3) above except that the roller shall be equipped with tires that will afford ground contact pressures to 90 pounds per square inch [620 kPa] or more.

CONSTRUCTION METHODS:

The embankment layer or the base course shall be sprinkled if directed, and rolling with a tamping roller unit shall start longitudinally at the sides and proceed toward the center, overlapping on successive trips by at

least one-half of the width of the tamping roller unit. On superelevated curves, rolling shall begin at the low sides and progress toward the high sides. Alternative trips of the unit shall be slightly different in length. Rolling shall continue until proper compaction is achieved. The light pneumatic tire roller shall be operated at a speed between 4 and 12 miles per hour [6 km/h and 19 km/h] for asphalt surfacing work and between 2 and 6 miles per hour [3 km/h and 10 km/h] for all other work.

The medium pneumatic tire roller shall be operated at speeds as directed by the Inspector.

Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another than one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

MEASUREMENT: Rolling (Pneumatic Tire) will not be measured for payment.

PAYMENT: The work prescribed herein will not be paid for directly, but shall be included in the unit price bid for the items of construction in which the operations occur.

ITEM 214
ROLLING
(Heavy Pneumatic Tire)

This Item shall govern for the compaction of embankment subgrade, flexible base, old concrete pavement, (previously broken) or pavements by the operation of approved heavy pneumatic tire rollers as herein specified and as directed by the Inspector.

EQUIPMENT: The heavy pneumatic tire roller shall consist of not less than four pneumatic tire wheels, running on axles carrying not more than two wheels, and mounted in a rigid frame and provided with a loading platform or body suitable for ballast loading. All wheels shall be arranged so that they will carry approximately equal loads when operating on uneven surfaces.

The roller under working condition shall have a rolling width of from 8 feet [2.5 m] to 10 feet [3 m], and shall be so designed that, by ballast loading, the gross load may be varied uniformly from 25 tons [23 megagrams] to 50 tons [45 megagrams]. The tires shall be capable of operating under the various loads with variable air pressure up to 150 pounds per square inch [1000 kPa]. The operating load and tire air pressure shall be within the range of the manufacturer's chart. Tires shall be practically full of liquid. (Tires shall be considered as being practically full when liquid will flow from the valve stem of a fully inflated tire with the stem in the uppermost position). The Contractor shall furnish the Inspector charts or tabulations showing the contact areas and contact pressures for the full range of the tire inflation pressures and for the full range of loadings for the particular tires furnished.

There shall be a sufficient quantity of ballast available to load the equipment to a maximum gross weight of 50 tons [45 megagrams].

Rubber tired tractive equipment shall be used on base courses and asphalt pavements. Other type tractive equipment may be used on embankment subgrade. The heavy pneumatic tire roller unit shall be capable of turning 180 degrees in the crown width.

The heavy pneumatic tire roller shall be the self-propelled type.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Inspector, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Inspector, its use shall be discontinued and the Contractor will be required to furnish the specified equipment.

CONSTRUCTION METHODS: The embankment layer or the base course shall be sprinkled if directed. Rolling with a pneumatic tire roller unit shall start longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least one-half of the width of the pneumatic tire roller. On superelevated curves, rolling shall begin at the low sides and progress toward the high sides. Alternative trips of the roller shall be slightly different in length. Rolling shall continue until desired compaction is achieved.

The rollers shall be operated at speeds directed by the Inspector which shall be between 2 and 6 miles per hour [3 km/h and 10 km/h].

Sufficient roller shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another than one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

MEASUREMENT: Rolling (Heavy Pneumatic Tire) will not be measured for payment.

PAYMENT: The work prescribed herein will not be paid for directly, but shall be included in the unit price bid for the items of construction in which the operations occur.

ITEM 216

ROLLING
(Proof)

This Item shall govern for furnishing and operating heavy pneumatic tired compaction equipment for locating unstable areas of earthwork or base.

EQUIPMENT. The proof rolling equipment shall consist of not less than four pneumatic tired wheels, running on axles carrying not more than two wheels, and mounted in a rigid frame and provided with loading platform or body suitable for ballast loading. All wheels shall be arranged so that they will carry approximately equal loads when operating on uneven surfaces.

The proof roller under working conditions shall have a rolling width of from 8 feet [2.5 m] to 10 feet [3 m], and shall be so designed that, by ballast loading, the gross load may be varied uniformly from 25 tons [23 megagrams] to 50 tons [45 megagrams]. The tires shall be capable of operating under the various loads with variable air pressure up to 150 pounds per square inch [1000 kPa]. Tires shall be practically full of liquid. (Tires shall be considered as being practically full when liquid will flow from the valve stem of a fully inflated tire with the stem in the uppermost position). The operating load and tire pressure shall be within the range of the manufacturer's chart. The Contractor shall furnish the Inspector charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the particular tires furnished.

The proof roller shall be the self-propelled type.

There shall be a sufficient quantity of ballast available to load the equipment to a maximum gross weight of 50 tons [45 megagrams].

Rubber tired tractive equipment shall be used on base courses and asphalt pavements. Other type tractive equipment may be used on embankment subgrade. The heavy pneumatic tire roller unit shall be capable of turning 180 degrees in the crown width or operating in forward and reverse modes.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the

Inspector, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Inspector, its use shall be discontinued.

CONSTRUCTION METHODS. This work shall be done only when directed by the Inspector. The subgrade and/or base layer shall be proof rolled to locate unstable areas when directed by the Inspector.

Within the ranges previously set forth, the load and tire inflation pressures shall be adjusted as directed by the Inspector. It is proposed to use a contact pressure corresponding as nearly as practical to the maximum supporting value of the earthwork or base. A minimum of two coverages of the proof roller will be required. Each succeeding trip of the proof roller shall be offset by not greater than one tire width. Rollers shall be operated at speeds directed by the Inspector which shall be between 2 and 6 miles per hour [3 km/h and 10 km/h].

Where the operation of the proof roller unit shows are area to be unstable or non-uniform, it shall be corrected in accordance with the applicable Item of Work.

MEASUREMENT. Rolling (Proof) will not be measured for payment.

PAYMENT. The work prescribed herein will not be paid for directly, but shall be included in the unit price bid for the items of construction in which the operations occur.

ITEM 217
ROLLING
(Vibratory)

This item shall govern for the compaction of embankments and all pavement structure courses except seal coat, surface treatments or portland cement concrete pavement by the operation of approved vibratory rollers as herein specified and as approved by the Inspector.

EQUIPMENT. Vibratory rollers shall be maintained in a satisfactory working condition.

(1) General. Vibratory rollers shall:
For Earth & Base

a) Be self propelled with at least one drum equipped to vibrate.

b) Be equipped with separate frequency and amplitude control for each vibrating drum.

c) Have the capability of starting and stopping the vibration manually.

d) Have the capability to continuously clean the face of the drum.

For Asphalt Stabilized Base & Asphaltic Conc. Pavement

a) Be self propelled with at least one drum equipped to vibrate.

b) Be equipped with separate frequency and amplitude control for each vibrating drum.

c) Have the capability of automatically reversing the direction of the rotating eccentric weight.

d) Automatically stop vibration before the motion of the rollers stop.

e) Have the capability of starting and stopping the vibration manually.

f) Have the capability of keeping the drum thoroughly moistened with water.

g) Have the capability to continuously clean the face of the drum.

(2) Type. The equipment to be used shall conform to the requirements as follows:

(a) Type A. Static weight shall be less than 6 tons [5.4 megagrams] and the vibratory drum shall be not less than 20 inches [508 mm] wide.

(b) Type B. Static weight shall be equal to or more than 6 tons [5.4 megagrams] and the vibratory drum shall be not less than 20 inches (508 mm) wide.

(3) Alternate Equipment. In lieu of the equipment specified, the Contractor may, upon written permission from the Inspector, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Inspector, its use shall be discontinued and the contractor will be required to furnish the specified equipment.

CONSTRUCTION METHODS. Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated form one another than one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

The Contractor shall furnish the Inspector the equipment Manufacturer's specifications concerning operating amplitude and frequency controls and settings.

The vibratory roller shall be operated in such a manner so as to produce the necessary compaction as specified, together with the following requirements.

(1) The vibration unit shall not be operated when the roller is stationary or when it is in contact with compacted finished embankment or pavement structure layer.

(2) In case of over vibration resulting in disruption of the compacted material, the Contractor shall rework

and recompact or replace the damaged material at his own expense.

(3) When compacting asphaltic concrete pavement, the vibrating roller shall be operated at a speed that will produce not less than 10 impacts (blows) per linear foot [30 blows per meter], unless otherwise shown on the plans or approved by the Inspector.

(4) When compacting asphaltic concrete pavement, the drum(s) shall be kept in a moist condition with water.

MEASUREMENT. Rolling (Vibratory) will not be measured for payment.

PAYMENT. The work prescribed herein will not be paid for directly, but shall be included in the unit price bid for the items of construction in which the operations occur.

ITEM 220
BLADING

This Item shall govern for blading those portions of the roadway as shown on the plans, or as directed by the Inspector.

EQUIPMENT. All equipment shall be approved by the Inspector prior to use and shall be able to efficiently produce the desired results. Unless otherwise specified, equipment used for blading shall be a power maintainer and shall be in good operating condition. The power maintainer shall have dual or four-wheel drive, shall be equipped with pneumatic tires, shall have a blade of not less than 12 feet [3.6 m] in length and a wheel base of not less than 16 feet [4.8 m]. A reduced blade length may be permitted by the Inspector, when site conditions prohibit use of a 12 foot [3.6 m] or longer blade. If the maintainer is not equipped with a satisfactory scarifier attachment, a scarifier of approved type shall be provided.

CONSTRUCTION METHODS. The work shall be performed and operated by capable and efficient operators. All areas shall be completed to the section, line and grade shown on the plans, or established by the Engineer.

When necessary to loosen materials prior to blading, or at other points when so directed by the Inspector, the scarifier attachment or separate scarifier shall be used. When a separate scarifier is used, it shall be drawn by suitable power equipment of adequate tractive effort. Around and adjacent to structures, trees, and other obstructions where it is impractical to do the required work with a blade, such work shall be done by hand methods or other means as approved by the Inspector.

The dragging, pushing or scarping of materials along or across completed pavements will not be permitted.

MEASUREMENT. Blading will not be measured for payment.

PAYMENT. The work prescribed herein will not be paid for directly, but shall be included in the unit price bid for the items of construction in which the operations occur.

ITEM 230
BASE AND PAVEMENT REPLACEMENT

This item shall govern for the removal and replacement of bases and/or pavements as herein specified and inconformity with the typical sections as shown on the plans and to the lines established by the Engineer.

MATERIALS:

1. Flexible Base: All flexible base shall conform to the provisions of Item No. 200, "Flexible Base".

2. Concrete: All concrete shall conform to the provisions of Item No. 300, "Concrete".

3. Reinforcing Steel: All reinforcing steel shall conform to the provisions of Item No. 301, "Reinforcing Steel".

4. Membrane Curing: All membrane curing shall conform to the provisions of Item No. 305, "Membrane Curing".

5. Prime Coat: All prime coat shall conform to the provisions of Item No. 202, "Prime Coat".

6. Tack Coat: All tack coat shall conform to the provisions of Item No. 203, "Tack Coat".

7. Hot Mix Asphaltic Concrete Pavement: All hot mix asphaltic concrete pavement shall conform to the provisions of Item No. 205, "Hot Mix Asphaltic Concrete Pavement".

8. Asphalt Treated Base: All asphalt treated base shall conform to the provisions of Item No. 206, "Asphalt Treated Base".

CONSTRUCTION METHODS:

1. Removal of Pavements: All concrete and asphaltic concrete pavements shall be cut with a concrete saw or other approved equally capable equipment. The depth of the cut shall be such that upon removal of concrete and/or asphaltic concrete, the sides of the cut will be straight and square. Care shall be taken when cutting concrete pavement so as to not cut transverse reinforcing steel.

Where existing base materials are to remain, pavements shall be removed to their full depth up to the top of the base material. Care shall be taken not to damage the existing base.

2. Removal of Bases: Removal of bases shall be unclassified, and shall include all materials encountered regardless of their nature or the manner in which they are removed. It is the intent of this specification that the base shall be removed in a manner that will leave the sides of the cut straight and square.

a. Concrete Bases: Concrete bases shall be removed by means of approved pneumatic pavement breakers and cutting bits. Where reinforcment is encountered in concrete bases, a minimum of one foot shall be cleaned of all old concrete and left in place to tie into the new reinforcement in the new concrete base.

b. Flexible, Asphalt Treated, and Cement stabilized bases: A rock saw or other approved equally capable equipment shall be used to cut the materials to the depth as specified. The base materials may then be removed by normal trenching operations. The cut edges of the existing pavement shall be vertical, straight and uniform.

3. Subgrade: The subgrade shall be shaped in conformity with the typical sections shown on the plans and to the lines and grades established by the Engineer by the removal of existing material or addition of approved material. All unstable or otherwise objectionable material shall be removed from the subgrade and replaced with approved materials. All holes, ruts, and depressions shall be filled with approved material. The surface of the subgrade shall be finished to the lines and grades as established, and be in conformity with the typical sections shown on the plans. Any deviation in excess of 1/2 inch [13 mm] in cross section and in length of 16 feet [5 m] measured longitudinally shall be corrected by loosening, adding, or removing material,reshaping and compacting by sprinkling and rolling. Sufficient subgrade shall be prepared in advance to insure satisfactory prosecution of the work.

All material required for completion of the subgrade shall be subject to approval by the Inspector.

Subgrade materials shall be compacted by approved mechanical tamping equipment to an apparent dry

density of the total material of not less than 90 percent of the maximum dry density as determined in accordance with TXDOT Test Method Tex-113-E.

4. Replacement of Materials: Replacement materials shall be of the type and thickness as shown on the plans.

a. Concrete Bases: All new concrete bases shall be replaced with class "A" concrete conforming to the provisions of Item No. 300, "Concrete". If the existing concrete is steel reinforced, the reinforcing steel shall be replaced in accordance with Item No. 301, "Reinforcing Steel". The concrete shall have a slump of not more than three (3) inches [76 mm] and shall be spaded, tamped and finished to the satisfaction of the Engineer. Immediately following finishing operations, the surface shall be cured in accordance with the provisions of Item No. 305, "Membrane Curing". The concrete shall be protected from traffic until proper curing has been obtained.

b. Flexible Bases: All new flexible base shall be furnished and placed in accordance with Item No. 200, "Flexible Base".

c. Asphalt Treated Bases and Hot Mix Asphaltic Concrete Pavements: All new asphalt treated base shall be furnished, placed and compacted in accordance with Item No. 206, "Asphalt Treated Base". Asphalt Treated Base shall be placed in maximum lifts of 4 inches [102 mm].

Pavements shall be replaced with hot mix asphaltic concrete pavement which shall be furnished and placed in accordance with Item No. 205, "Hot Mix Asphaltic Concrete Pavement". Asphaltic mixtures shall be at a temperature between 225 °F. [107 °C], and 350° F [177 ° C]., when placed. When the temperature of the asphaltic mixtures fall below 200° F [93 °C]., the mixture shall be rejected and payment will not be made for the rejected material.

Flexible bases shall be primed with asphalt or emulsion in accordance with the provisions of Item No. 202, "Prime Coat" prior to the placement of hot mix asphaltic concrete. All exposed concrete, asphalt treated base, and cement stabilized bases shall receive a tack coat of asphalt or emulsion in accordance with the provisions of Item No. 203, "Tack Coat" prior to placement of new hot mix asphaltic concrete pavement.

MEASUREMENT: "Base and Pavement Replacement" will be measured by the square yard [square meter] of base or pavement replaced, of the type and depth indicated in the plans and bid proposal, to the limits shown on the plans, regardless of the types of materials encountered upon removal. Materials used in replacing bases and pavements such as flexible base, concrete, asphaltic concrete pavement, reinforcing steel, prime coat, and tack coat will not be measured directly for payment. The depth will be measured from the top of pavement to the bottom of new base or pavement material.

PAYMENT: Payment for base and pavement replacement will be made at the contract unit price bid per square yard [square meter] for "Base and Pavement Replacement" of the type and depth classification shown on the plans. The contract unit price bid for "Base and Pavement Replacement" shall be considered a full compensation for cutting and removing pavements, removing bases, preparing subgrade, replacing with new bases and pavements, removing and disposing of all surplus materials, furnishing and placing all new materials, and for all manipulations, work, tools, equipment, labor and incidentals necessary to complete the work.

BID ITEMS:

Item 230: Replacing Base And Pavement With Flexible Base And Pavement, (____inches [mm] compacted depth) - per square yard [square meter].

Bid Item 230.1: Replacing Base And Pavement With Asphalt Treated Base And Pavement, (_____inches [mm] compacted depth) - per square yard [square meter].

Bid Item 230.2: Replacing Base And Pavement With Concrete Base And Pavement, (____ inch [mm] depth) - per square yard [square meter].

Bid Item 230.3: Replacing Base And Pavement With Hot Mix Asphaltic Concrete Pavement, Type B, (_____ inch [mm] depth) per square yard [square meter].

Bid Item 230.4: Replacing Pavement (_____inch [mm] maximum compacted depth) - per square yard [square meter].

ITEM 234
BASE REINFORCEMENT

This item shall govern for the furnishing and placing of polymer grid reinforcement of the size and quantity designated for use with the flexible base requiring reinforcement as shown on the plans and in accordance with these specifications.

MATERIALS:

Polymer grid reinforcement material shall be TENSAR Geogrid Type SS1 (BX-1100) as manufactured by the Tensar Corporation, Morrow, Georgia; or approved equal.

CONSTRUCTION METHODS:

1. Subgrade soil shall be prepared in accordance with Specifications Item No. 104 "Street Excavation and No. 107, "Embankment", prior to placement of geogrid reinforcement.

2. Geogrid reinforcement shall be rolled out parallel to the road direction at the proper elevation and alignment as shown on the construction drawings.

3. Geogrid sections shall be overlapped a minimum of one 1 foot [305 mm]. Placement of geogrid around corners will require cutting of geogrid product and diagonal overlapping.

4. Contractor shall take steps to ensure that geogrid sections do not separate at overlaps during construction.

5. Base material shall be placed and compacted in accordance with Specification Item 200, "Flexible Base". This material shall be back dumped from trucks riding on top of the reinforced base material and bladed on to the grid ahead.

6. Tracked construction equipment shall not operate directly upon the geogrid. A minimum base thickness of 4 inches [102 mm] is required prior to operation of trucked vehicles over the geogrid.

7. Rubber tired equipment may pass over the geogrid at slow speeds, less than 10 miles per hour [16 km/h] if the subgrade material is capable of supporting the loads without excessive rutting or causing damage to the grid. Equipment operators shall avoid sudden braking or sharp turning.

8. If ruts are created in the base material due to construction traffic, they shall be filled with additional base material rather than blading adjacent material into the rut.

MEASUREMENT. Accepted work as prescribed by this item will be measured by the square yard [square meter] of base reinforcement complete in place in accordance with the plans with no allowance made for width of overlaps required.

PAYMENT. The work performed as prescribed by this item will be paid for at the contract unit price bid per square yard [square meter], measured as prescribed above, for "Base Reinforcement" which price shall be full compensation for furnishing all labor, materials, equipment and other items necessary and incidental to completion of work.

BID ITEM:

Item 254: Base Reinforcement - per square yard [square meter].

DIVISION III

CONCRETE AND CONCRETE STRUCTURES

ITEM 300
CONCRETE (NATURAL AGGREGATE)

This item shall govern for the material used; for storing and handling of materials; and for the proportioning, mixing and transportation of concrete for all concrete construction.

This specification does not cover the placement, consolidation, curing, or protection of the concrete.

MATERIAL: The concrete shall be composed of Portland Cement, mineral filler, if necessary, natural aggregates (fine and coarse), and water, proportioned and mixed as hereinafter provided in these specifications. Concrete shall meet all the requirements as set forth in ASTM C-94.

CLASSIFICATIONS AND PROPORTIONS: The minimum cement content, maximum allowable water content, and maximum slump of the various classes of concrete shall conform to Table 1.

MEASUREMENT:
The quantities of concrete of the various classifications which constitute the completed and accepted structure will be measured by the cubic yard [cubic meter] in place. Only accepted work will be included, and the dimensions used will be those shown on the plans or ordered in writing by the Engineer. No deductions in measurement will be made for paneling less than 3 inches [76 mm] in width by 1 inch [25 mm] in depth, for chamfers less than 2 inches [51 mm], for embedded reinforcing steel, or for embedded portions of structural steel members.

PAYMENT:
The concrete quantities, measured as provided above, will be paid for at the contract unit prices bid per cubic yard [cubic meter] for the various classifications of concrete shown, which prices shall be full compensation for furnishing, hauling and mixing all concrete materials; placing, curing, and finishing all concrete; all grouting and pointing; furnishing and placing all drains and expansion joints, except as hereinafter provided; furnishing and placing metal flashing strips; and for all forms and falsework, labor, tools, equipment, and incidentals necessary to complete the work.

The above provisions for payment shall not be interpreted to provide payment for concrete in railings, piling, concrete culvert pipe, precast prestressed concrete units, or other concrete items for which provision is otherwise made in the contract.

The above provisions for payment for drains and expansion joints shall not be interpreted to provide payment for cast iron or structural steel shapes used in drains; for structural steel, cast iron or cast steel bearing plates; or for steel members used in armoring roadway joints. Payment for these materials is provided for in Item No. 302, "Metal for Structures".

No direct measurement or payment will be made for Concrete Class "G", but shall be considered subsidiary to the particular items required by the plans and the contract.

BID ITEMS:
ITEM 300.1 - Concrete Class "A" - per cubic yard [cubic meter].

ITEM 300.2 - Concrete Class "B" -per cubic yard [cubic meter].

ITEM 300.3 - Concrete Class "C" -per cubic yard [cubic meter].

ITEM 300.4 - Concrete Class "D" -per cubic yard [cubic meter].

TABLE 1

Class	Minimum compressive strength @ 28 days psi [MPa]	Maximum water-cement ratio	Slump range inches [mm]	Mim. - max sacks cement per cubic yard [cubic meter]
A	3,000 [20]	7.0	2 - 5 [50 -125]	5.0
B	2,500 [17]	8.0	2 - 5 [50 - 125]	4.5
C	2,000 [14]	9.0	1 - 4 [25 - 102]	4.0
D	1,000 [6]	11.0	1 - 4 [25 - 102]	2.0
G	(as specified on plans)	5.50	2 - 3 [50 - 80]	6.0 - 8.0

ITEM 301
REINFORCING STEEL

This item shall provide for the furnishing and placing of bar reinforcing steel of the size and quantity designated for use in structures and other concrete items that require reinforcing steel as shown on the plans and in accordance with these specifications.

MATERIALS:

Reinforcing steel shall be grade 60 and all bar reinforcement shall be deformed, conforming to the requirements of item 440, "Reinforcing Steel" of the Texas Department of Transportation Standard Specifications. Reinforcing steel bars produced outside of the United States are acceptable if such bar reinforcement conforms to the requirements of the ASTM Specifications for the various designations of bars.

BENDING, TOLERANCES AND STORAGE:

Bending, tolerances and storage of reinforcing steel shall conform to articles 440.3, "Bending", 440.4, "Tolerances", and 440.5, "Storage" in Item 440, "Reinforcing Steel" of the Texas Department of Transportation Standard Specifications.

SPLICES:

No splicing of bars, except when provided on the plans, will be permitted without approval of the Engineer.

PLACING REINFORCEMENT:

All steel reinforcing shall be accurately placed in the position shown on the plans and firmly held during the placing and setting of concrete. All reinforcement shall be free from dust, rust, mill scale, paint, oil, mortar or foreign material. Bars shall be tied at all intersections, except that where spacing of bars in each direction is less than 12 inches [305 mm], only alternate intersections need be tied. Distances from forms shall be maintained by means of stays, precast blocks, ties, hangers, metal chairs or other approved supports. Blocks for holding reinforcing bars from contact with the forms shall be precast concrete blocks of approved shape and dimensions or other equally suitable-devices. The use of pebbles, pieces of broken stones or brick, metal pipe and wooden blocks shall not be permitted. Reinforcement in any sections shall be placed and then inspected and approved by the Inspector before the placing of concrete begins.

MEASUREMENT:

The measurement of quantities of bar reinforcing furnished and placed, will be based an the calculated weight of the steel actually placed in accordance with the plans and these specifications, with no allowance made for added bar lengths for splices nor for extra steel used when bars larger than those specified are substituted with the permission of the Consulting Engineer. Tie wires and supporting devices will not be included in the calculated weights. The calculated weight of bar reinforcement will be determined using the theoretical bar weight set forth in Table No. 1 with no allowance for overrun or underruns:

PAYMENT:

Reinforcing Steel measured as provided above, will be paid for at the contract unit price bid per pound [kilogram] of "Reinforcing Steel", which price shall be full compensation for furnishing, bending, fabricating, welding and placing reinforcement; for all clips, blocks, metal spacers, ties, wire or other materials used for fastening reinforcement in place, and for all tools, labor, equipment and incidentals necessary to complete the work.

Payment for reinforcing in items which specifically include the cost of reinforcement shall be paid for as provided in the specifications for those items.

BID ITEM:

Item 301 - Reinforcing Steel - per pound [kilogram].

TABLE 1

Bar size number (mm)	***Nominal diameter inches(mm)***	***Nominal Area square inch (mm^2)***	***Weight per linear foot (kg/m)***
2 (6)	***0.250 (6.35)***	***0.05 (32.26)***	***0.167 (0.249)***
3 (10)	***0.375 (9.525)***	***0.11 (70.97)***	***0.376 (0.560)***
4 (12)	***0.500 (12.7)***	***0.20 (129.03)***	***0.668 (0.994)***
5 (15)	***0.625 (15.875)***	***0.31 (200.00)***	***1.043 (1.552)***
6 (20)	***0.750 (19.05)***	***0.44 (283.87)***	***1.502 (2.235)***
7 (22)	***0.875 (22.225)***	***0.60 (387.10)***	***2.044 (3.042)***
8 (25)	***1.000 (25.4)***	***0.79 (509.68)***	***2.670 (3.973)***
9 (28)	***1.128 (28.651)***	***1.00 (645.16)***	***3.400 (5.060)***
10 (30)	***1.270 (32.258)***	***1.27 (819.35)***	***4.303 (6.404)***
11 (35)	***1.410 (35.814)***	***1.56 (1006.45)***	***5.313 (7.907)***
14 (40)	***1.693 (43.00)***	***2.25 (1451.61)***	***7.65 (11.384)***
18 (55)	***2.257 (57.328)***	***4.00 (2580.64)***	***13.60 (20.239)***

ITEM 302
METAL FOR STRUCTURES

This item shall govern for materials, such as structural steels, alloy steels, rivet steel, high strength bolts, forgings, steel casting, iron castings, wrought iron, bronze, steel pipe and tubing, aluminum castings and tubing, and other, metals used in structures, except reinforcing steel and metal culvert pipe, and for the fabrication and erection of structural steel and other metals, except reinforcing steel, which are used for steel or steel portions of structures.

MATERIALS:

Metal for Structures: Metal for structures shall comply with the requirements as set forth under Item No. 442 "Metal for Structures" of the Texas Department of Transportation Standard Specifications.

Paint: Paint shall comply with the requirements as set forth under Item No. 514, "Paint and Painting".

CONSTRUCTION METHODS:

Construction of "Metal for Structures" shall comply with the requirements as set forth under Item No. 441, "Steel Structures" of the Texas Department of Transportation Standard Specifications.

MEASUREMENT:

Measurement of the quantity of structural metal furnished and placed will be based on the weight of metal in the fabricated structure. The weight of erection bolts, paint, and all boxes, crates, or other containers used for packing, together with sills, blocking and rods used for supporting or protecting members during transportation shall be excluded. When increases in size or weights of members have been made which were not ordered by the Consulting Engineer, but approved by him, the measurement will be made on the sizes or weights shown on the contract plans.

In determining the weight of structural metal in steel or concrete structures, such items as castings, bearing plates, anchor bolts, drains, deck plates, armor joints, finger joints, and all other metal for which no separate measurement is specified, will be considered as metal for structures.

The weights of rolled shapes and of plates shall be computed on the basis of their nominal weights and dimensions, as shown on the approved shop plans.

The weight of castings will be computed from the dimensions shown on the approved shop drawings. Shoes will be measured by the weights as shown on the standard shoe details, or as specified for castings above, if weights are not shown.

Deductions will be made for all cuts, copes, perforations, and all holes except rivet or bolt holes. The weight of rivet heads will be included for payment. No weight shall be allowed for weld metal.

A change in design which either increases or reduces the quantity of metal going into the structure or structures will be measured by the actual computed weights of the metal, and the quantity as shown on the plans and in the contract, will be increased or decreased by the revised weights, as the case may be.

PAYMENT:

Structural metal will be paid for at the contract unit price bid per pound [kilogram] for "Metal for Structures", or for such other classifications as shown on the plans and in the proposal.

Payment will not be made until shop bills of materials, based on approved shop drawings, indicating total weight of material used have been received and checked by the Consulting Engineer.

This price shall be full compensation for furnishing all materials and for all fabrication, shopwork, transportation, erection, paint and painting, galvanizing, and for furnishing all equipment tools, labor, and incidentals necessary to complete the work.

BID ITEM:

Item 302 - Metal for Structures - per pound [kilogram].

ITEM 303
WELDED WIRE FLAT SHEETS

This item shall govern the furnishing of the various sizes of welded wire flat sheets as indicated on the plans or as directed by the Engineer.

MATERIAL: All welded wire flat sheets used in construction shall conform to the requirements of ASTM A-185. Welded wire rolls shall not be used.

CONSTRUCTION METHODS: All splices between the welded wire flat sheets shall overlap sufficiently to allow the distance between the outer-most cross wires of each lapped fabric sheet to be not less than the spacing of the cross wires plus 2 inches [50 mm].

Distances from forms or concrete surfaces shall be maintained by means of stays, precast blocks, ties, hangers, metal chairs or other approved supports. The use of pebbles, pieces of broken stones or brick, metal pipe and wooden blocks shall not be permitted.

At the edge of the construction, the wire fabric shall not be less than 1 inch [25 mm] nor more than 3 inches [76 mm] from the edge of the concrete and shall have no wires projecting beyond the last member parallel to the edge of the concrete.

MEASUREMENT:
No measurement of welded wire flat sheets will be made.

PAYMENT:
No direct payment for furnishing and placing welded wire flat sheets will be made. All materials and labor required will be considered subsidiary to the item in which it is used and shall be included in the unit price bid for said item.

ITEM 304
EXPANSION JOINT MATERIALS

This item shall govern for the furnishing and placing of all expansion joint material as herein specified in the various items of these specifications or as shown on the plans or as directed by the Engineer.

MATERIAL: The material used for expansion joints shall conform to either of the following:

1. Preformed Bituminous Fiber Material shall be formed from cane or other suitable fibers of a cellular nature securely bound together and uniformly impregnated with a suitable asphaltic binder and shall meet the requirements of the Standard Specifications for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction, ASTM D-1751.

2. Boards for expansion joints shall be obtained from Redwood or Cypress timber and shall be sound heartwood, free from sapwood, knots, clustered birdseye, checks and splits. occasional sound or hollow birdseye, when not in clusters, will be permitted provided the board is free from any other defects that will impair its usefulness as a joint filler.

CONSTRUCTION METHODS:

All materials used shall extend the full depth of the concrete and shall be perpendicular to the exposed face. All joints shall be shaped to conform to the contour of the finished section in which they are installed. All material shall be a minimum of 1/2 inch [13 mm] thick.

MEASUREMENT:

Expansion Joint materials will not be measured for payment.

PAYMENT:

No direct payment will be made for Expansion Joint Materials. All material supplied and installed as specified herein shall be considered subsidiary work to the various items of these specifications calling for Expansion Joint Materials.

ITEM 305
MEMBRANE CURING

This item shall consist of curing by the impervious membrane method of all curbs, sidewalks, driveways, drive approaches, concrete riprap, concrete structures and other concrete as specified in the various items of these specifications or as indicated in the plans.

MATERIALS:

The membrane curing compound shall comply with the "Standard Specification for Liquid Membrane-forming Compounds for Curing Concrete", ASTM C309, Type I clear or translucent without dye, Type 1-D clear or translucent with fugitive dye, or Type 2 white pigmented. The vehicle shall be Class A - no restrictions on vehicle solids material, or Class B - vehicle solids restricted to all resin material. The material shall have a minimum flash point of 80° F [27 °C]. when tested by the "Pensky-Martin Closed Cup Method'.

It shall be of such consistency that it can be satisfactorily applied as a fine mist through an atomizing nozzle by means of approved pressure spraying equipment at atmospheric temperatures above 40° F [4 °C].

It shall be of such a nature that it will not produce permanent discoloration of concrete surfaces nor react deleteriously with the concrete nor its components. Type I-D compound shall contain a fugitive dye that will be distinctly visible not less than 4 hours nor more than 7 days after application. Type 2 compound shall not settle out excessively or cake in the container and shall be capable of being mixed to a uniform consistency by moderate stirring and shall exhibit a daylight reflectance of not less than 60 percent of that of magnesium oxide.

The compound shall produce a firm, continuous, uniform moisture impermeable film free from pinholes and shall adhere satisfactorily to the surfaces of damp concrete. It shall, when applied to the damp concrete surface, at the rate of coverage specified herein, dry to touch in not more than 4 hours and shall not be tacky or track off concrete after 12 hours. It shall adhere in a tenacious film and when sprayed, in a single application at the specified rate, on the vertical face of damp concrete, shall not run off or appreciably sag.

The compound shall not disintegrate, check, peel or crack during the required curing period. It shall not peel or pick up under traffic and shall disappear from the surface of the concrete by gradual disintegration.

The compound shall be delivered to the job only in the manufacturer's original sealed containers which shall be legibly marked with the name of the manufacturer, the trade name of the compound, the type of compound and class of vehicle, the nominal percentage of non-volatile material, and a batch number or symbol with which test samples may be correlated.

The permissible percentage moisture loss (at the rate of coverage specified herein) shall not exceed the following:

24 hrs. after application.....2%
72 hrs. after application.....4%

CONSTRUCTION METHODS:

Just before using the membrane curing compound, it shall be thoroughly agitated in its original container until any settlement has been uniformly redispersed. Redispersion shall be checked with a 1 inch by 1 inch [25 mm x 25 mm] wooden slat or similar device scraped along the interior of the container and then examined for accumulation of settlement and uniformity of dispersion. The compound shall be maintained in a uniform condition, substantially free of settlement, during its use.

The compounds shall not be applied to a dry surface and if the surface of the concrete has become dry, it shall be thoroughly moistened by water fogging prior to application of membrane.

The membrane curing compound shall be applied after the surface finishing has been completed, and immediately after the free surface moisture has disappeared. The surface shall be sealed with a single coat of the specified type of curing compound applied uniformly at the rate of coverage recommended by the manufacturer and directed by the Inspector, but not less than one (1) gallon per 180 square feet [1 liter per 5 square meters] of surface area. The curing compound shall not be thinned or

diluted in any manner prior to application. The Contractor shall provide satisfactory means and facilities to properly control and check the rate of application of the compound.

At locations where the coating shows discontinuities, pinholes, or other defects, or if rain falls on the newly coated surface before the film has dried sufficiently to resist damage, an additional coat of the compound shall be applied immediately at the same rate of coverage specified herein.

To insure proper coverage, the Inspector will inspect all treated areas after application of the compound for the period of time designated in the governing specification for curing, either for membrane curing or for other methods. Dry areas are identifiable because of the lighter color of dry concrete as compared to damp concrete. All suspected areas shall be tested by placing a few drops of water on the suspected areas. If the water stands in round beads or small pools which can be blown along the surface of the concrete without wetting the surface, the water-impervious film is present. If the water wets the surface of the
concrete as determined by obvious darkening of the surface or by visible soaking into the surface, no water-impervious film is present. Should the foregoing test indicate that any area during the curing period is not protected by the required water-impervious film, an additional coat or coats of the compound shall be applied immediately, and the rate of application of the membrane compound shall be increased until area areas are uniformly covered by the required water-impervious film.

When temperatures are such as to warrant protection against freezing, curing by this method shall be supplemented with an approved insulating material capable of protecting the concrete for the specified curing period.

If at any time, there is reason to believe that the method of curing is unsatisfactory or is detrimental to the work, the Contractor, when notified, shall immediately cease the use of this method and shall change to curing by one of the other methods specified under this contract.

MEASUREMENT:

"Membrane Curing" will not be measured for payment.

PAYMENT:

The work and materials prescribed herein will not be paid for directly, but shall be included in the unit price bid for the items of construction in which these materials are used.

ITEM 306
STRUCTURAL EXCAVATION

Only when indicated on the plan details and bid proposals will this item govern the excavation for the placing of structures, and for the disposal of all material obtained from such excavation, and for backfilling around completed structures to the level of the original ground. The work to be done under this item shall include all necessary pumping or bailing, sheathing, drainage and the removal of all structures or portions thereof, such as wingwalls, culverts, inlets, trees and all other obstructions necessary to the proposed construction.

CLASSIFICATION:

All structural excavation shall be unclassified, and shall include all materials encountered regardless of their nature or the manner in which they are removed, except those covered by other pay items of the contract.

CONSTRUCTION METHODS:

1. Excavation: Excavation shall be done in accordance with the lines and depths indicated on the plans or as established by the Engineer. Limits of excavation for payment shall be to a vertical plane 1 foot [305 mm] outside and parallel to the footing. In instances where the structure is stepped outward near the top, the limits of excavation will be increased accordingly. in all cases where excavation diagrams are shown on the plans, such diagrams shall take precedence over these provisions. Excavated material required to be used for backfilling may be deposited by the Contractor at points convenient for rehandling, provided such deposits do not constitute a hazard and provided all hubs and survey lines are kept free of any obstruction.

2. Backfilling: Structural backfilling shall consist of back-filling for footings, bridge structures, headwalls, wingwalls, retaining walls, transition walls, drop inlets, manholes, and all appurtenant structures. Care shall be taken in the backfilling process so as not to induce any movement in the structure or to induce shear forces greater than those for which the structure is designed. Structural backfilling shall be carried to the top of natural ground, or to the proposed grade shown on the plans, as the case may be, by method (a) (b) or (c) below. Backfill behind walls shall not begin until the concrete has attained a compressive strength of 2,000 p.s.i [15 MPa]. Backfill on top of supporting slabs shall not begin until concrete has attained a compressive strength of 3,000 p.s.i. [20 MPa].

(a) Material for backfill shall be placed in uniform layers not more than 12 inches [305 mm] in depth (loose measurement) and, if dry, it shall be wetted uniformly with a spray nozzle to the moisture content required to obtain the specified density and shall be compacted to the required density by means of a mechanical tamper.

(b). A clean gravel, or gravel approved by the Consulting Engineer, conforming to the requirements of Item No. 410, "Subgrade Filler" may be used for backfill material from the bottom of the trench to the top of the conduit. The gravel shall be placed in the trench and lightly tamped to consolidate and seat the mass against conduit and earthen surfaces. A filter fabric shall be placed between the gravel backfill (initial backfill) and secondary backfill. The filter material shall have an apparent opening size of U.S. Sieve No. 40. Where conditions permit and with approval of the Consulting Engineer, a gravel conforming to Item 200 "Flexible Base" may be used from the top of the filter blanket, to the top of the box culvert. This backfill material shall be placed in uniform layers not more than 12 inches [305 mm] in depth (loose measurement) and shall be compacted to the required density. Each layer of material, if dry, shall be wetted uniformly with a spray nozzle to the moisture content required to obtain the specified density and shall be compacted to the required density by means of a mechanical tamper.

(c) Controlled low strength material (CLSM). CLSM shall be placed by direct discharge from a mixer truck or other approved method. A minimum of 30 psi [1 MPa]. at 3 days and maximum strength of 800 psi [5 MPa]. at 28 days is required. There is no separate pay item for Controlled Low Strength Material.

MEASUREMENT:

Structural excavation as prescribed by this item will be measured to the limits as described above and will be computed by the method of average end areas. No measurement will be made of any excavation, made by the Contractor for his convenience, beyond the limits specified above.

PAYMENT:

The work performed as prescribed by this item will be paid for at the unit price bid per cubic yard [cubic meter] for 'Structural Excavation', which price shall be full compensation for all excavation (within the limits set forth) and backfill including compaction, pumping, bailing, sheathing, bracing, and for furnishing all materials, labor, equipment tools, and incidentals necessary to complete the work.

BID ITEM:

Item 306 - Structural Excavation - per cubic yard [cubic meter].

ITEM 307
CONCRETE STRUCTURES

This item shall govern for the construction of box culverts, headwalls, wingwalls, bridges, box transitions, approach slabs, retaining walls, inlets, storm sewer structures, sanitary sewer structures and incidental structures. All concrete structures shall be constructed in accordance with specifications herein outlined and in conformity with the required lines, grades, sections and details shown on the plans or as directed by the Engineer.

MATERIALS:

1. Concrete: All concrete shall conform to the provisions of Item No. 300, "Concrete (Class A)" or shall be of class as noted on the plans.

2. Reinforcing Steel: All reinforcing steel shall conform to the provisions of Item No. 301, "Reinforcing Steel".

3. Membrane Curing Compound: All membrane curing compound shall conform to the provisions of item No. 305 "Membrane Curing'.

4. Expansion Joint Materials: All expansion joint materials shall conform to the provisions of item No. 304, "Expansion Joint Materials".

5. Cast Iron Castings: All cast iron castings shall conform to the provisions of Item No. 409, "Cast Iron Castings".

6. Metal for Structures: Metal for structures shall conform to the provisions of Item No. 302, "Metal for Structures".

CONSTRUCTION METHODS:

1. Forms: Forms shall be of wood, metal or other approved materials and shall conform to the following requirements:

a. Wood Forms:

(1) Unexposed concrete surfaces, No. 2 common or better lumber.

(2) Exposed concrete surfaces, dressed and matched boards of uniform thickness and width.

b. Plywood: Commercial standard Douglas Fir, moisture resistant, concrete form plywood, not less than 5 ply and at least 9/16th of an inch [14 mm] in thickness. The face of the plywood shall be free from knot holes and other blemishes.

c. Metal Forms: Metal forms of an approved type that will produce surfaces equal to or better than those specified for wood forms.

Forms may be constructed of any of the above substances or of other material if suited to the intended purpose and when approved by the Inspector. Forms shall be built mortar tight and of sufficient strength to prevent bulging between supports and shall be set and maintained to the line and grade designated until the concrete is sufficiently hardened to permit removal. All details of form construction shall be subject to the approval of the Inspector, and in special cases the approval of the Engineer may be required. Permission to place concrete will not be given by the Inspector until all form work has been placed in accordance with the above requirements. If at any stage of the work, the forms show signs of bulging, sagging or moving, that portion of the concrete causing such condition shall be immediately removed if required by the Inspector and the forms reset and securely braced against further movement.

All corners and edges, which will be exposed after construction, shall be chamfered with triangular chamfer strips 3/4 inch [19 mm] measured on the sides.

2. Placing Reinforcement: All steel reinforcement shall be placed in accordance with item No. 301, "Reinforcing Steel".

3. Placing Concrete: The base slabs of inlets, junction boxes, headwalls, culverts and other structures shall be placed and allowed to set before the remainder of the structure is constructed. Suitable provision shall be made for bonding the sidewalls to the base slab by

means of longitudinal keys so constructed as to prevent the percolation of water through the construction joints. Before concrete is placed in the walls, the keyed-edge joints shall be thoroughly cleaned of all shavings, sticks, trash or other extraneous materials. The top slabs of culverts and like structures may be poured monolithic with the walls, provided the walls are poured and allowed to set a minimum of one (1) hour, but no more than two (2) hours shall elapse between the placing of the concrete in the wall and that in the top slab; such interval is to allow for shrinkage of the concrete in the wall. Under adverse weather conditions the minimum time will be increased by the Inspector.

All concrete shall be placed with the aid of mechanical vibrating equipment supplemented inside the forms. Vibrating equipment shall be of the internal type and shall maintain a speed of 6000 impulses per minute, when submerged in concrete. Vibrators shall be adequate in number of units to properly consolidate all concrete. Form or surface vibrators shall not be used. The duration of vibration shall be limited to that required to properly consolidate the concrete without causing objectionable segregation of aggregates. Insertion of vibrators into lower courses that have commenced initial set, or the disturbance or reinforcement in concrete beginning to set shall be avoided.
Concrete shall not be allowed to drop freely more than 5 feet [1.5 m] in unexposed work, nor more than 3 feet [1 m] in exposed work; where greater drops are required, a tremie or other approved means shall be employed. Concrete shall not be placed when the ambient temperature is below 40° F. [4 °C], nor where the concrete is likely to be subject to freezing before final set has occurred. When the air temperature is expected to drop below 40° F. [4 °C] during the first 72 hours of the curing period, polyethylene sheeting or burlap-polyethylene blankets shall be placed in direct contact with the top surface of the concrete. Concrete may be poured in temperatures below 40° F. [4 °C]. when poured in protected areas, or where adequate protection can be provided against freezing, if approved by the Inspector. When concrete is poured in air temperatures above 85° F. [30 °C], an approved retarding agent, meeting the requirements of ASTM C494, Type B, will be required in all concrete used in superstructures and top slabs of culverts unless directed otherwise by the Inspector.

4. Form Removal: Forms shall be removed only with the approval of the Inspector and in a manner to insure complete safety of the structure where the structure as a whole is supported on shoring. Form removal from structures shall not begin until the concrete has attained the following compressive strengths:

a. Vertical forms shall not be removed until the concrete has set a minimum of twenty-four (24) hours, or the concrete has attained a minimum compressive strength of 500 p.s.i. [3 MPa]

b. When wall and top slabs are poured monolithicly, wall forms shall not be removed until the concrete has attained a minimum compressive strength of 2000 psi [14 MPa]

c. Forms for the top slab shall not be removed until the top slab has-attained a minimum compressive strength of 2000 psi [14 MPa].

5. Finish: Honeycomb and other minor defects shall be patched with cement mortar composed of one (1) part cement to two (2) parts fine aggregate. All exposed surfaces shall be given one of the following finishes:

a. Rough Finish: Concrete for which no other finish is indicated or specified shall have fins and rough edges removed.

b. Smooth Finish: Smooth finish shall be given to the interior of inlets, junction boxes, culverts and other structures. Joint marks, fins and rough edges shall be smoothed off and blemishes removed, leaving finished surfaces smooth and unmarred subject to approval by the Inspector.

c. Floor Finish: Floor finish shall be given to the floors of all inlets, culverts and other structures, and shall be struck off true to the required grade as shown on the drawings and floated to a smooth, even finish by manual or mechanical methods. No coarse aggregate shall be visible after finishing.

d. Rubbed Finish: All exposed surfaces of retaining walls, wingwalls, headwalls and other structures, after patching and pointing has been completed, and the surface has been wetted, shall be given a first rubbing with a No. 16 Carborundum Stone. After the first rubbing is completed and the ground material has been evenly spread, the material shall be allowed to take a reset. After sufficient aging, the surface shall be wetted and given a finish rubbing with a No. 30 Carborundum Stone, after which the surface shall be neatly striped with a brush and allowed to take a reset. On the inside surfaces of all culvert walls an area from the top slab, on a line 30 degrees from the vertical, to the bottom slab shall be rubbed as specified above. The entire structure shall be left with a clear neat uniform finish, free from form markings and shall be uniform in color.

e. Sidewalk surfaces shall be given a wood float finish, a light broom finish, or may be stripped with a brush as directed by the Inspector or specified in the plans.

f. Roadway slabs shall be given a broom finish after completion of the floating or straight-edging operation, but before the disappearance of the moisture sheen. The grooves of the finish shall be parallel to the centerline of the roadway. The average texture depth

of the grooves shall be a minimum of 0.035 inches [1 mm].

The Contractor has the option of substituting the surface finish described in item No. 311 "Special Concrete Surface Finish" on the surface areas listed in the specification.

6. Curing: Immediately after placing or finishing, concrete surfaces not covered by forms shall be protected from loss of surface moisture for not less than four (4) curing days. When forms are left in place they shall be kept sufficiently wet to reduce cracks in the forms and prevent the form joints from opening. if forms are removed before four (4) curing days have transpired, the formed surface shall be protected for the remainder of the four (4)-day curing period. Protection and curing shall be accomplished by one of the following methods and shall be subject to the approval of the Inspector during the entire curing process:

a. Water Curing: Water curing shall be effected by covering exposed surfaces with cotton or burlap mats, previously wetted before applying, and kept thoroughly wet during the entire curing period. The application of the mats shall not mar or disturb surfaces which will be exposed on completion.

b. Membrane-Compound Curing: Membrane-compound curing shall conform to the provisions of Item No. 305, 'Membrane Curing".

7. Fine Grading: All fine grading of structure foundations shall provide for seating on firm, clean natural earth foundation except as otherwise provided. Any under-cut foundations, except where authorized, shall be corrected to the satisfaction of the Inspector at the sole expense of the Contractor.

8. Excavation and Backfilling shall conform to Item No. 306, "Structural Excavation".

MEASUREMENT AND PAYMENT:

No direct measurement or payment will be made for the work to be done or the equipment to be furnished under this item, but shall be considered subsidiary to the particular items of work for which unit prices are required in the proposal.

ITEM 308
DRILLED SHAFTS AND UNDER-REAMED FOUNDATIONS

This item shall govern for the construction of foundations consisting of reinforced concrete shafts with or without bell type concrete footings. Concrete shafts shall be placed in drilled excavation when the shafts are without bell type footings and in drilled and under-reamed excavation when shafts are with bell type footings. Such foundations shall be constructed in conformance with the details and governing dimensions shown on the plans.

TEST HOLE INFORMATION: Logs of test holes dug at the sites are shown in the plans. Test holes have been shown for the purpose of establishing bottom of drilled shaft foundations and determining elevation of ground water, or other soil characteristics, and shall in no way guarantee, either explicit or implied, the actual soil condition encountered at each particular drilled shaft location. The Consultant reserves the right to either lengthen or shorten the depth of drilled shaft shown on the plans, due to actual soil conditions encountered in the field.

MATERIALS:

1. Concrete: All concrete shall conform to the provisions of Item No. 300, "Concrete (Class "A") or shall be of the class as noted on the plans.

2. Reinforcing Steel: All reinforcing steel shall conform to the provisions of Item No. 301, "Reinforcing Steel".

CONSTRUCTION METHODS:

(1) Excavation

General. The plans indicate the expected depths and elevations where satisfactory bearing material will be encountered.

The Contractor shall perform the excavation required for the shafts and bell footings, through whatever materials encountered, to the dimensions and elevations shown on the plans or required by the site conditions. If satisfactory foundation material is not encountered at plan elevation, the bottom of the shaft will be adjusted, or the foundation altered, as determined by the Consultant, to satisfactorily comply with design requirements.

Shaft alignment shall be within a tolerance of 1 inch per 10 feet [25 mm per 3 m] of depth.

The center of the shaft shall not be more than one 1 inch [25 mm] from the horizontal position shown on the plans. Any shafts in violation of this tolerance will be subject to a structural review by the Consultant.

Where caving conditions and/or excessive ground water is encountered, no further drilling will be allowed until a construction method is employed which will prevent excessive caving that will cause the excavation to be appreciably larger than the size of casing to be used. Predrilling in disturbed soil as necessary to control ground water and caving until a casing is set or setting casing with a vibratory hammer, will be permitted.

Casing will be required when necessary to prevent caving of the material or when necessary to exclude ground water. Casing shall be of sufficient strength to withstand handling stresses, the pressure of concrete and of the surrounding earth or backfill materials, and shall be watertight, smooth, clean and free of accumulations of hardened concrete.

When casing is used, the minimum shaft diameter below the casing shall not be less than the specified diameter of the shaft.

Under normal operations, a sufficient head of concrete shall be maintained at all times above the bottom of the casing to overcome hydrostatic pressure. Movement of the casing for short pulls of a few inches, rotating, exerting downward pressure and tapping it to facilitate extraction will be permitted. The total removal of the casing shall not be started until all concrete placement is completed in the shaft. When unusual conditions warrant, the casing may be pulled in partial stages. Casing extraction shall be at a slow, uniform rate with the pull in line with the axis of the shaft.

Casing shall not be left in place unless otherwise shown on the plans or permitted by the Consultant.

Bells shall be excavated to form a bearing area of the size and shape shown on the plans. Blasting will not

be permitted. Bell shapes varying slightly from those shown on the plans are permissible provided the bearing area equals that specified.

Material excavated from shafts and bells, including slurry, and not used in the backfill around the completed bents or piers shall be disposed of by the Contractor.

At the time concrete is placed, the excavation shall be free from accumulated seep water. All loose material shall be removed from the bottom of the excavation prior to placing concrete.

The Contractor shall provide suitable access and lighting for proper inspection of the completed excavation, and to check the dimensions and alignment of shafts and bell excavation.
Any required lighting shall be electric. Any mechanical equipment used within the excavation shall be operated by air or electricity. The use of gasoline driven engines within the excavation for pumping or drilling will not be permitted.

When the plans require shafts in abutment bents, the embankment at the bridge ends shall be completed to grade and thoroughly compacted prior to drilling, unless otherwise shown on the plans or as permitted by the Consultant.

(2) Reinforcing Steel. The cage of reinforcing steel, consisting of longitudinal bars and lateral reinforcement (spiral reinforcement, lateral ties or horizontal bands) shall be completely assembled and placed as a unit immediately prior to concrete placement, unless otherwise shown on the plans.

If the shaft is lengthened, the longitudinal bars and lateral reinforcement required in the upper portion of the shaft shall be extended to the bottom unless otherwise shown on the plans. These bars may be lap spliced or spliced by welding. Any splices required shall be in the lower portion of the shaft.

Where spiral reinforcement is used, it shall be tied to the longitudinal bars at a spacing not to exceed 12 inches [305 mm]. Welding of lateral reinforcement to longitudinal bars will not be permitted unless otherwise shown on the plans.

In uncased shafts, concrete spacer blocks or steel chairs shall be used at sufficient intervals to insure concentric spacing for the entire length of the cage. In cased shafts, concrete spacer blocks shall not be used. Steel chair spacers or bent pieces of steel bars shall be placed at sufficient intervals around the steel cage to insure concentric spacing inside the casing.

It shall be the Contractor's responsibility to support or hold down the cage to control vertical displacement during concrete placement and/or extraction of the casing. The support shall be concentric with the cage to prevent racking and distortion of the steel. An adequate number of the vertical bars shall be supported.

The elevation of the top of the steel cage shall be checked before and after concrete placement or after casing extraction when casing is used. Generally, downward movement of the steel not exceeding 6 inches per 20 feet [152 mm per 6 m] of shaft length will be acceptable. Upward movement of the steel not exceeding 6 inches [152 mm] will be acceptable. Displacement of the steel beyond the above limit shall be cause for a structural review.

The minimum length of steel required for lap with column steel shall be maintained. Dowel bars may be used if the proper lap length is provided both into the shaft and into the column. All dowel bars shall be adequately supported and may be inserted after concrete placement.

(3) Concrete.

(a) General. All work shall be performed in accordance with the provisions of Item 307, "Concrete Structures", and with the requirements herein.

Concrete shall be placed as soon as possible after all excavation is complete and reinforcing steel placed, and shall be of such workability that vibrating or rodding will not be required. Portions of drilled shafts which are formed shall be vibrated.

Concrete placing shall be continuous for the entire length of the shaft. Concrete shall be placed through a suitable tube or tremie to prevent segregation of materials. Free fall of concrete a maximum of 15 feet [5 m] will be allowed provided the Contractor can demonstrate that the concrete may be directed such that it does not strike the reinforcing cage or sides of the hole during placement.

The elapsed time from the beginning of concrete placement in the cased portion of the shaft, until extraction of the casing is begun, shall not exceed one (1) hour.

A riser block of equal diameter as the column and of a maximum height of 6 inches [152 mm] may be cast at the top of the completed shaft.

The top surface shall be cured and any construction joint area shall be treated in accordance with Item 307, "Concrete Structures".

MEASUREMENT:

1. The drilled shaft of the specified diameter, in place in accordance with these specifications, complete and accepted, will be measured by the linear foot [meter] of acceptable shaft in place, between the bottom of the

footing and the top of the shaft as indicated by the details shown on the plans.

2. Bell Footings, in place in accordance with these specifications, complete and accepted, will be measured by the cubic yard (cubic meter) of concrete. The bell shall be deemed to consist of the footing volume outside of the volume of the drilled shaft which, for purposes of measurement, is considered as extending to the bottom of the bell.

PAYMENT:

Payment for drilled shafts and bell footings shall be at the unit price bid per linear foot [meter] for the specified diameter of "Drilled Shafts", and at the unit price bid per cubic yard [cubic meter] for Bell Footings", each measured as specified under "Measurement" and such unit prices shall be full compensation for making all excavations, doing any necessary pumping, placing and removing any required casing, furnishing and placing all-concrete and reinforcing steel, all backfilling, and furnishing all tools, labor, equipment and incidentals necessary to complete the work. No extra payment will be made for casings left in place. Where the bottom of the drilled shaft is ordered to be placed at an elevation below plan grade and a splice of reinforcement is required, payment will be made at the unit price bid per pound [kilogram] for Item No. 301, "Reinforcing Steel" for the extra reinforcement required to make one lap splice per bar of a length determined by the Consultant. The splice required above the top of the drilled shaft shall be considered as included in the unit price bid for drilled shafts.

No partial estimates will be allowed for "Bell Footings" or for "Drilled Shafts" until the concrete has been placed.

BID ITEMS:

Item 308.1 - Drilled Shafts - per linear foot [meter].

Item 308.2 - Bell Footing - per cubic yard [cubic meter].

ITEM 309
PRECAST REINFORCED CONCRETE BOX CULVERTS

This item shall govern for the fabrication and placing of precast reinforced concrete box culverts. The boxes shall be placed in accordance with the lines and grades shown on the plans and as staked in the field.

MATERIALS:

1. Precast Reinforced Concrete Box Culverts: Precast Reinforced Concrete Box Culverts shall be fabricated in accordance with one of the following design criteria:

a. ASTM Designation C789 and C850.

b. Texas Highway Department Special Specification 4090.

c. Precast Design prepared by Registered Professional Engineer. Design plans covering the structural requirements of the precast section shall be prepared, signed and sealed by a Registered Professional Engineer.

The precast box design shall be made at the Contractor's expense and must be approved by the Engineer.

2. Joint Material: Joint material for precast reinforced concrete box culverts of all kinds shall meet the requirements for cold applied, plastic asphalt sewer joint compound or cold applied pre-formed plastic gaskets as specified in Item 401.

3. Bedding: Under any and all ground conditions encountered, clean gravel subgrade filler (Item 410) shall be used as bedding material.

CONSTRUCTION METHODS:

1.Excavation, Trenching and Backfilling: All excavation, trenching and backfilling shall be in accordance with Item 106, "Box Culvert Excavation and Backfilling" of the Standard City Specifications.

2. Bedding: The soil shall be excavated to a depth of 4 inches [102 mm] minimum below the established grade of the bottom of the box culvert for the full width of the culvert and replaced with graded-gravel conforming to Item 410-B, "Clean Gravel Subgrade Filler". Additional excavation may be required by the

presence of ground water, or other objectionable material. Such extra excavation shall be performed and replaced with graded gravel only upon approval of the Inspector.

3. Installation: Unless otherwise authorized by the Engineer, the laying of box culverts on the prepared foundation shall start at the outlet end. Box culverts shall be laid with the tongue end pointing downstream and shall proceed toward the inlet end with the abutting sections properly matched, true to the established lines and grades. Proper facilities shall be provided for hoisting and lowering the box culvert sections into the trench without disturbing the prepared foundation and sides of the trench. The boxes shall be fitted and matched so that when laid on the foundation they shall form a smooth, uniform conduit.

Multiple box sections shall be placed leaving a space of a minimum of 1 inch [25 mm] and a maximum of 2 inches [50 mm] between the outside face of adjacent walls of the boxes. After the boxes have been placed and jointed, this space shall be filled with a grout composed of one (1) part Portland Cement and two (2) parts of sand.

4. Jointing: All preparation and priming of joints, application of joint compound, and construction methods shall be in strict adherence to the manufacturer's recommendations.

5. Backfilling: After the boxes have been placed and jointed as specified, backfilling shall be accomplished in accordance with the requirements of Item 106, "Box Culvert Excavation and Backfilling" of these specifications.

MEASUREMENT:

Precast Reinforced Concrete Box Culverts will be measured by the linear foot [meter] of box of the various sizes. Measurement shall be made along the centerline of the box in place. Box culverts will not be classified as to depth.

PAYMENT:

Payment for Precast Reinforced Concrete Box Culverts measured as set out above will be made at the contract unit bid price for various size boxes. Payment shall be full compensation for furnishing, hauling, placing and backfilling the box culverts. All excavation will be paid under Item No. 106, "Box Culvert Excavation and Backfilling". Subgrade filler, regardless of thickness, will be paid under Item No. 410B, "Clean Gravel Subgrade Filler".

BID ITEM:

Item 309 - Precast - Reinforced Concrete Box Culverts per linear foot [meter].

ITEM 310
PRECAST, PRESTRESSED BRIDGE BEAMS

This item shall govern for the completed construction, prestressing, and erection of precast, prestressed concrete beams, and for the furnishing, storing, and handling of materials for prestressing of the beams, except as otherwise noted on the plans.

GENERAL:

The general requirements for fabrication, for materials, and for construction methods for use in this contract shall be in accordance with TXDOT Standard Specificiations Item No. 425, "Prestressed Concrete "Structural Members"; Item No. 426, "Prestressing"; and Item No. 435, "Elastomeric Materials".

MEASUREMENT:

Precast, Prestressed Bridge Beams, cast and stressed as required by the plans will be measured by the linear foot [meter], along the centerline of beam, complete and in place in the bridge.

PAYMENT:

Precast, prestressed concrete bridge beams will be paid for at the contract unit price bid per linear foot [meter] of beams of the type specified. The price paid shall be full compensation for constructing the members, furnishing and tensioning prestressing steel, furnishing and placing reinforcing steel, furnishing all anchorage hardware and elastomeric bearing pads, grouting, and all other appurtenances which become an integral part of the beams, and shall be full compensation for furnishing all materials, tools, equipment, labor, and incidentals necessary to fabricate, transport, and erect the beams in the structure as indicated on the plans.

BID ITEM:

Item 310 - Precast, Prestressed Bridge Beams - per linear foot [meter].

ITEM 311
SPECIAL CONCRETE SURFACE FINISH

This item shall govern for the furnishing and applying of a special textured coating to concrete bridges, culverts or other structures in lieu of the "rubbed finish" described in Item No. 307, "Concrete Structures".

PLACEMENT:

For bridges, the coating shall be applied to the top exterior and roadway surfaces of parapet walls; exterior vertical faces of slabs, slab spans, arches and box girders; the outside and bottom surfaces of fascia beams, girders, prestressed girders and exterior box beams; the underside of slabs to the point of juncture with the supporting beam; all vertical surfaces of bents, piers and abutments the bottom surfaces of bent caps; and all tie beams and wingwalls exposed to view after backfilling. In the case of "spill-through" type abutments, exposed vertical surfaces shall be coated for a distance of five feet from the edge of the bridge. For culverts, the coating shall be applied to the areas described in item No. 307, Concrete Structures. For retaining walls, or other structures, all surfaces exposed to view after backfilling shall be coated unless indicated otherwise in the plans.

MATERIALS:

Coating materials shall be either an adhesive grout material or a paint-type coating as described in article 4, "Class of finish" as "Class A" or "Class B' coatings of Item No. 4000 "Surface Finishes for Concrete" of the Special Specifications of the Texas Department of Transportation. The color shall be "concrete gray" unless shown otherwise on the plans. Coatings shall meet the test requirements of Article 6, "Test Requirements" of Item No. 4000, "Surface Finishes for Concrete" of the Special Specifications of the Texas Department of Transportation.

CONSTRUCTION METHODS:

For "Class A" and "Class B" materials, concrete surfaces shall be clean and free of dirt, grease, curing compound or any other bond breaking substance. "Class A" coatings shall be applied on moistened surfaces. "Class B" coatings shall be applied to a dry surface. The temperature of the atmosphere, concrete and coating compound shall be above 50° F. [10 °C] at time of application. The finished surfaces shall be protected against rain or freezing for a period of 24 hours after application. "Class A" coatings shall be sprayed, rolled or brushed. "Class B" materials shall be sprayed in a manner to provide an acceptable texture and proper coverage. "Class A" and "Class B" materials shall be applied after all preparation work required for a "Smooth Finish" under Item No. 307, "Concrete Structures" has been completed, and just prior to final acceptance of the work.

MEASUREMENT AND PAYMENT:

No direct measurement or payment will be made for the work to be done or the materials to be furnished under this item. Such work and materials shall be considered as subsidiary to the several items of work for which unit prices are required in the proposal.

DIVISION IV
STORM SEWERS

ITEM 400
EXCAVATION, TRENCHING AND BACKFILLING

This item shall govern the excavation, trenching and backfilling for storm drainage pipe, and pipe culverts, unless otherwise noted on the plans, details and the specifications. The work shall include all necessary pumping or bailing, sheeting, drainage and the construction and removal of any required cofferdams. All existing utilities shall be protected from damage during the excavation and backfilling of trenches, and if damaged, shall be replaced or repaired by the Contractor at his expense. Unless otherwise shown on the plans and bid proposal all excavation shall be unclassified, and shall include all materials encountered regardless of their nature or the manner in which they are removed.

EXCAVATION: The Contractor shall perform all excavation of every description and of whatever substances encountered, to the lines and grades shown on the plans or determined by the Engineer. During excavation, material suitable for backfilling shall be stockpiled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave ins. All excavated materials not required or not suitable for backfill shall be removed and properly disposed of by the Contractor or as directed by the Engineer. Such grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved methods. Sheeting and shoring shall be done as may be necessary for the protection of the work, adjoining property, and for the safety of the personnel. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled, if in the opinion of the Engineer, the pipe or structure can be safely and properly installed or constructed, and backfill can be properly tamped in such tunnel sections.

TRENCHING:

1. Trench walls shall be vertical and the practice of undercutting at the bottom or flaring at the top will not be permitted unless at the Engineer's direction. In special cases where trench flaring is permitted and directed by the Engineer, the trench walls shall remain vertical to a depth of at least 1 foot [305 mm] above the top of the pipe. The bottom of the trench shall be square or slightly curved to the shape of the trenching machine cutters. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of pipe on the undisturbed soil at every point along its entire length, except for the portions of pipe sections where it is necessary to excavate for bells and for the proper sealing of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded in order that the pipe may rest upon the prepared bottom for as nearly its full length as practicable. Whenever over-excavation occurs, the under-cut trench shall be restored to grade, to the satisfaction of the Inspector, by replacement of excavated material compacted to the same density as the surrounding natural ground.

Whenever wet or otherwise unstable soil that is incapable of properly supporting the structure or pipe, as determined by the Engineer, is encountered in the bottom of the trench, such soil shall be removed to the depth shown on the plans or determined by the Engineer and the trench backfilled to the proper grade with a subgrade filler as specified in Item No. 410, "Gravel Subgrade Filler".

The depth of cut indicated on cut sheets, as furnished by the Consultant, is from the off-set or cut hub elevation to the invert of the pipe. The width of the trench shall be at least the outside diameter of the pipe plus 6 inches [152 mm] on each side of the pipe for pipe sizes under 42 inches [1050 mm] in diameter.

The maximum working room for pipe 42 inches [1050 mm] in diameter and under shall not exceed 1/2 of the outside diameter of the pipe or 12 inches [305 mm] whichever is greater, from the edge of the pipe to the face of the trench walls, or inside face of the shoring protection. For pipe over 42 inches [1050 mm] in diameter the maximum width of the trench shall be such that the working space from the pipe to the trench wall, or shoring protection as the case may be, will be a minimum of 12 inches [305 mm], and a maximum of 24 inches [610 mm]. If allowable trench widths are exceeded through over-shooting of rock, caving of earth trenches or over excavation, the Contractor shall

employ corrective measures or alternative designs as determined by the Engineer.

It shall be understood that the depth of cut as indicated on the cut sheet may be more or less than the actual excavated depth due to ground conditions existing at the site. For this reason the Consultant shall determine the depth for pay purposes based on the surface elevation prior to the Contractor's operation and the invert of the sewer line. The Consultant's decision shall be final.

2. Where water, silt, muck, trash, debris or rock in ledge, boulder or coarse gravel (particle size larger than 1 3/4 inch [44 mm] is encountered at the bearing level, the Contractor shall, as directed by the Inspector, under-excavate and remove such materials to a depth not less than 4 inches [102 mm] below the bottom of the pipe and replace with a material conforming to the requirements of Item 410, "Gravel Subgrade Filler".

BACKFILLING:

1. General: Excavation shall not be backfilled until the constructed structures or appurtenances as installed conform to the requirements specified. The excavation shall be carefully backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, flexible base material, sand and gravel, soft shale or other approved materials, free from large clods of earth or stones.

Where pipe is specially coated for protection against corrosion, care shall be taken not to damage the coating. Any excavation improperly backfilled, or where settlement occurs, shall be re-opened to the depth required for proper compaction, then refilled and compacted with the surface restored to the required grade and compaction. The use of sand backfill shall not be allowed.

All compaction shall be such that the apparent dry density of each layer shall be not less than ninety percent (90%) of the maximum dry density as determined by tests on samples as outlined in TXDOT Testing Method Tex 113-E, unless otherwise shown on the plans.

2. Storm Drainage Pipe Backfilling: Pipe backfilling to a point 12 inches [305 mm] above the top of the pipe shall be done by either method (a), (b) or (c) below. Backfilling from a point 12 inches [305 mm] above the top of the pipe to the top of trench or proposed subgrade elevation, shall be done by method (d) below.

(a). Material for backfill shall be selected fine compactable soil material. It shall be compacted at near optimum moisture content in layers not to exceed 6 inches [152 mm] in compacted thickness. Each layer shall be compacted to the required density by approved hand or mechanical tamping equipment. Care shall be exercised to thoroughly compact the backfill under the haunches of the pipe and to insure that the backfill soil is in intimate contact with the sides of the pipe. Backfill material shall be kept at the same elevation on both sides of pipe.

(b). A clean gravel or gravel approved by the Engineer, conforming to the requirement of Item No. 410, "Gravel Subgrade Filler" may be used for backfill material. The gravel shall be placed in the trench and lightly tamped to consolidate and seat the mass against the conduit and earthen surfaces. Backfill material shall be kept at the same elevation on both sides of pipe.

(c). Cement Stabilized Backfill shall conform to "Class D" Concrete as defined in Item No. 300 "Concrete" of these specifications. Cement Stabilized Backfill shall be placed within one (1) hour after mixing and shall be placed and rodded in such a manner as to completely fill the backfill area.

Before placing Cement Stabilized Backfill, the trench shall be cleaned of any extraneous material and thoroughly wet. All surplus dirt excavated from the ditch shall be removed from the site.

(d). After the backfill has been completed to a point 12 inches [305 mm] above the top of the pipe by one of the methods outlined above, suitable rolling equipment may be used on these portions which are accessible to such equipment to obtain the compaction effect. Material for backfill shall be placed in uniform layers no more than 12 inches [305 mm] in depth (loose measurement) and shall be compacted to the density specified herein. Each layer of backfill material, if dry, shall be wetted uniformly prior to placement in the trench to the moisture content required to obtain the specified density, and shall be compacted to the required density by means of rolling equipment or other suitable mechanical method. No rolling equipment shall be used which may damage the pipe.

DISPOSAL OF EXCAVATED MATERIALS: The excess excavated material, not utilized after all fill requirements have been met, shall become the property of the Contractor and he shall dispose of it by hauling and wasting outside the limits of the right-of-way of this project and of public thoroughfares and water courses, in conformity with pertinent City ordinances and in a manner meeting the approval of the Engineer.

MEASUREMENT: Excavation, Trenching and Backfill will not be measured for payment.

PAYMENT: No direct payment shall be made for excavation, trenching and backfilling for pipe culverts, pipe storm sewers, and all costs in connection therewith shall be included in the applicable contract price for the item to which the work pertains.

Excavation for reinforced concrete box culverts will be measured and paid for at the contract unit price bid per cubic yard [cubic meter] under Item No. 106, "Box Culvert Excavation and Backfill".

Subgrade filler will be measured and paid for at the contract unit price as provided for in Item No. 410, "Gravel Subgrade Filler."

ITEM 401
STORM DRAINAGE PIPE

This item shall govern the furnishing and placing of reinforced concrete culvert pipe, metal pipe, and storm sewer appurtenances. The pipe shall be installed in accordance with the requirements of these specifications, to the line and grades shown on the plans, and shall be of the sizes and dimensions shown thereon. The installation of pipe shall include all joints or connections to new or existing pipes, manholes, headwalls or other appurtenances as may be required to complete the work.

MATERIALS:

1. Pipe - Pipe for culverts shall be of the following types, manufactured in accordance with the requirements of the specifications for each type.

a. Reinforced Concrete Culvert Pipe: Reinforced Concrete Culvert Pipe shall conform to all requirements of ASTM Standard Specification C-76 or C-655.

b. Corrugated Metal Culvert Pipe & Arch Pipe: Corrugated Metal Culvert Pipe & Arch Pipe shall comply to the requirements of AASHTO Designation M-36 or ASTM Specification A-760 for galvanized pipe; or, shall comply to the requirements of AASHTO Designation M-245 or ASTM Specification A-762 for polymeric pre-coated pipe. Pipe shall be of the size, type and gauge as shown on the plans.

c. Jacking and Boring Pipe: Reinforced concrete pipe for jacking, boring or tunneling shall meet the requirements of the pertinent ASTM specification with the following additional requirements.

The pipe shall have circular reinforcement and for 30 inch [750 mm] and larger diameters shall have an additional layer of class III reinforcement, 12 inches [305 mm] long, extending into both the tongue and groove of the joint to within 3/4 inch [19 mm] of the end of the tongue and groove. The minimum wall thickness shall be wall "B" for the diameter specified, unless special design are required. The minimum concrete compressive strength for jacking and boring pipe shall be 5000 psi [35 MPa]. Variations in the laying length of opposite sides shall not exceed 3/8 inch [10 mm] for pipe diameters 24 inches [600 mm] through 60 inches [1500 mm] and 1/2 inch [13 mm] for pipe 66 inches [1650 mm] and larger. The maximum joint taper shall be 7 degrees for tongue and groove pipe and 2 degrees for O-ring gasket pipe. Pipe manufactured to these additional requirements shall be marked to identify pipe for jacking and boring.

2. Plastic joints shall be made with Cold Applied Plastic Asphalt Sewer Joint Compound or Cold Applied Preformed Plastic Gaskets meeting the following requirements: Application of the jointing material and construction methods recommended by the manufacturer shall be strictly adhered to.

a. Cold Applied, Plastic Asphalt Sewer Joint Compound. This material shall consist of natural and/or processed asphalt base, suitable volatile solvents and inert filler. The consistency is to be such that the ends of the pipe can be coated with a layer of the compound up to one-half inch [13 mm] thick by means of a trowel. The joint compound shall cure to a firm, still plastic condition after application. The material shall be of a uniform mixture and any small separation occurring in the container shall be stirred to a uniform mix before use.

b. Cold Applied Preformed Plastic Gaskets. Preformed plastic gaskets shall be suitable for sealing joints of tongue and groove concrete pipe. The gasket sealing the joint shall be produced from blends of refined hydrocarbon resins and platicizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes or obnoxious odors. The gasket joint sealer shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength, and shall be supplied in extruded rope-form of suitable cross-section. The size of the plastic gasket joint sealer shall be in accordance with the manufacturer's recommendations and be of sufficient size to properly seal the joint. The plastic gasket joint sealer shall be so constructed as to provide evidence of proper installation either by means of "squeeze-out" of the gasket material on the inside or outside around the complete pipe joint circumference or by means of tabs,

projections or other such indicator placed at established intervals around the circumference of the pipe joint. Plastic gasket joint sealers shall be Type 1 or Type 2. Type 1 gaskets shall meet the "squeeze-out" requirements and Type 2 gaskets shall meet the requirements for tabs, projections or other indicators. The gasket joint sealer shall be protected by a suitable wrapper designed that when removed, the jointing material maintains integrity.

3. Corrugated Metal Pipe Joints: Corrugated metal pipe joints shall be made with materials and construction methods recommended by the manufacturer.

CONSTRUCTION METHODS:

Reinforced concrete pipe culverts shall be constructed from the specified materials in accordance with the following methods and procedure:

1. Excavation: All excavation shall be in accordance with the requirements of Item 400, "Excavation, Trenching and Backfilling", except where tunneling or jacking methods are shown on the plans or permitted by the Engineer. The Contractor shall make such temporary provision as may be necessary to insure adequate drainage of the trench and bedding during the construction operation.

2. Bedding: The pipe shall be bedded in accordance with the details shown on the plans.

3. Unstable Materials: Where the soil encountered at the established grade is quicksand, muck, or similar unstable material, unless special construction methods are called for on the plans or in the special provisions, such unstable soil shall be removed and replaced in accordance with the requirements of Item 400.

4. Laying Pipe. Unless otherwise authorized by the Engineer, the laying of pipe on the prepared foundation shall be started at the outlet end. Reinforced concrete pipe shall be laid with the spigot or tongue end pointing downstream and shall proceed toward the inlet end with the abutting sections properly matched, true to the established lines and grades. Corrugated metal pipe shall be laid with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the side. Where bell and spigot pipe is used, cross trenches shall be cut in the foundation to allow the barrel of the pipe to rest firmly upon the prepared bed. Proper facilities shall be provided for hoisting and lowering the sections of pipe into the trench without disturbing the prepared foundation and the sides of the trench. As each length of pipe is laid, the mouth of the pipe shall be protected to prevent the entrance of earth or bedding material. The pipe shall be fitted and matched so that when laid in the bed it shall form a smooth, uniform conduit. When elliptical pipe with circular reinforcing or circular pipe with elliptical reinforcing is used, the pipe shall be laid in the trench in such position that the markings "Top" or "Bottom", shall not be more than five degrees (5°) from the vertical plan through the longitudinal axis of the pipe.

Pipe over 30 inches [750 mm] in diameter may have holes not larger than 3 inches [76 mm] in diameter, in the top of the pipe, to aid in lifting and placing.

After the pipe is laid, the holes shall be filled with grou5t plugs supplied by the manufacturer. Plugs shall be installed with plactic gasket materials or a grout patch applied over the plug as a seal.

5. Jointing.
(a) Joints using Cold Applied, Plastic Asphalt Sewer Joint Compound shall be made as follows:

Both ends of the pipes shall be clean and dry. A one-half inch (13 mm) thick layer of the compound shall be troweled or otherwise placed in the groove end of the pipe covering not less than two-thirds of the joint face around the entire circumference. Next, the tongue end of the next pipe shall be shoved home with sufficient pressure to make a tight joint. After the joint is made, any excess mastic projecting into the pipe shall be removed. Special precautions shall be taken in placing and compacting backfill to avoid damage to the joints.

(b) Joints using Rubber Gaskets shall be made as follows:

Where rubber gasket pipe joints are required by the plans, the joint assembly shall be made according to the recommendations of the gasket manufacturer. Water tight joints will be required when using rubber gaskets. Backfilling may begin when approved by the Engineer.

(c) Joints using Cold Applied Preformed Plastic Gaskets shall be made as follows:

Before laying the pipe in the trench, the plastic gasket shall be attached around the tongue or groove near the shoulder or hub of each joint in accordance with the gasket manufacturer's recommendations. The protective wrapper shall be removed and the gasket pressed firmly to the clean, dry surface of the pipe, as recommended by the manufacturer. The joint sealer must be placed in such a manner that no dirt or other deleterious materials will come in contact with the joint sealing material.

After the tongue is correctly aligned with the flare of the groove, the wrapper or wrappers on the gasket shall be removed and the pipe shall be pulled or pushed home with sufficient force to properly seal the joint. Any joint material pushed out into the interior of the pipe that would tend to obstruct the flow shall be removed. (Pipe shall be pulled home in a straight line with all parts of the pipe on line and grade at all times.) Special

precautions shall be taken in placing and compacting backfill to avoid damage to the joints.

When the atmospheric temperature is below 60° F [16° C], plastic joint seal gaskets shall either be stored in an area warmed to above 70° F [21 °C], or artificially warmed to this temperature in a manner satisfactory to the Inspector. Gaskets shall then be applied to pipe joints immediately prior to placing pipe in trench, followed by connection to previously laid pipe.

6. Backfill: After the pipe has been placed, bedded, and jointed as specified, filling and/or backfilling shall be done in accordance with the requirements of Item No. 400, "Excavation, Trenching and Backfilling".

MEASUREMENT: Storm drainage pipe will be measured by the lineal foot [meter] of pipe of the various sizes, regardless of strengths involved, as measured along the centerline of the pipe in place, from inside wall of structure to inside wall of structure, or as shown on the plans. Pipe will not be classified as to strength. Trunkline pipe will be classified as to depth from the natural ground before construction begins to the invert of the pipe. Laterals, so designated on the plans, will be classified as to size but not by depth.

PAYMENT: Storm drainage culvert pipe will be paid for at the contract unit price bid per linear foot [meter] complete in place for the type and size constructed. Trunkline pipe will be classified as to depth for payment. Laterals pipes, so designated on the plans, will not be classified as to depth for payment. Said price shall be full compensation for furnishing, hauling and placing of the pipe at locations and on the grades indicated on the plans, for all excavation and backfilling, connections to existing structures, capping end of pipe where indicated, and all other items of labor, equipment, materials, tools and incidentals necessary to complete the work in accordance with the plans and specifications. Subgrade filler if required will be paid for under Item 410, "Subgrade Filler". Depths of cut for payment will be measured from the top of ground prior to beginning of construction and along the centerline of pipe to the invert of the pipe.

BID ITEMS:

Item 401.1: Storm Drainage Pipe (Reinforced Concrete) - per linear foot [meter] (per depth of cut).

Item 401.2: Storm Drainage Pipe (Corrugated Metal) per linear foot [meter] (per depth of cut).

Item 401.3: Bends - per each.

ITEM 402
HIGH DENSITY CORRUGATED POLYETHYLENE PIPE

This item shall govern for the furnishing and installing of all 18 inch (450 mm) to 36 inch (900 mm) diameter corrugated polyethylene pipe and/or materials for constructing corrugated polyethylene pipe culverts or storm sewer, mains, laterals, stubs and connections. The pipes shall be of the sizes, types, and dimensions shown on the plans and shall include all connections and joints to new or existing pipes, sewer manholes, inlets, headwalls and other appurtenances as may be required to complete the work.

MATERIALS:

(1) **General.** Unless otherwise specified on the plans or herein, high density corrugated polyethylene pipe shall conform to the following:

AASHTO M-294 (latest edition)

Corrugated polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds, and shall conform to the cell classifications as listed in AASHTO M-294 and meet or exceed the requirements of ASTM D3350 forn the cell class 324420C.

Corrugated polyethylene pipe of all types may be fabricated with annular corrugation or helical corrugations, conforming to AASHTO M-294 (latest edition).

A certificate of compliance shall be furnished to the engineer for each type of plastic pipe furnished. Certification shall state that the pipe meets the following minimum values:

Pipe Diameter in [mm]	Wall Area (in/ft)	Avg. Moment of Inertia (in/in)
18 [450]	3.00	0.085
24 [600]	4.00	0.200
30 [750]	4.35	0.400
36 [900]	4.40	0.520

(2). **Coupling Bands.** Except as otherwise required herein, coupling bands and other hardware for corrugated polyethylene pipe shall demonstrate that they meet the soil tightness requirements of AASHTO section 23.3.1.5.4 "Standard Specifications for Highway Bridges".

Coupling bands shall lap equally on each of the pipes being connected to form a tightly closed joint after installation.

The corrugations in the band shall index the corrugations in the pipe ends to engage the first or second corrugation from the end of each pipe.

When infiltration or exfiltration is a concern, the coupling may be required to have gaskets. The gasket material shall be closed-cell expanded rubber or neoprene.

(3). Designation of Type. The types of pipe will be indicated on the plans by the following descriptions:

Pipe Description: CPP - Corrugated Polyethylene Pipe.

Type C - This pipe shall have a full circular cross-section, with a corrugated surface both inside and outside.

Type S - This pipe shall have a full circular cross-section, with an outer corrugated pipe wall and a smooth inner liner.

Corrugated polyethylene pipe shall be installed in accordance with the plans and requirements herein. (Refer to ASTM D-2321 for further information.)

CONSTRUCTION METHODS:

(1) **Excavation.** All excavation shall be in accordance with the requirements of Item 400. "Excavation, Trenching and Backfilling" , except where tunneling or jacking methods are shown on the plans or permitted by the Engineer.

(2) **Shaping and Bedding.** The pipe shall be bedded in a foundation of compacted cohesionless material, such as sand, crushed stone, or gravel, with a maximum size not exceeding 11/2 inch [38 mm]. This

material shall extend a minimum of 6 inches [152 mm] below the outer most corrugations or ribs, and shall be carefully and accurately shaped to fit the lowest part of the pipe exterior for at least ten (10) percent of the overall height. When requested by the Engineer, the Contractor shall furnish a template for each size and shape of pipe to be placed for use in checking the shaping of the bedding. The template shall consist of a thin plate or board cut to match the lower half of the cross section of the pipe.

(3) **Laying Pipe.** Unless otherwise authorized by the Engineer, the laying of pipes on the bedding shall be started at the outlet end, the separate sections firmly joined together, outside laps of annular joints pointing upstream and longitudinal laps on the sides. Proper facilities shall be provided for hoisting and lowering the section of pipe into the trench without damaging the pipe or disturbing the bedding and the sides of the trench. Any pipe which is not in alignment or which shows any undue settlement after laying shall be taken up and relayed without extra compensation.

Multiple installation of corrugated polyethylene pipe shall be laid with the center lines of individual barrels parallel. Unless otherwise indicated on the plans, the following clear distances between outer surfaces of adjacent pipes shall be maintained:

Diameter of Pipe	Clear Distance Between Pipes
18" [450 mm]	14" [355 mm]
24" [600 mm]	17" [432 mm]
30" [750 mm]	20" [508 mm]
36" [900 mm]	23" [534 mm]

(4) **Culvert Connections.** Where new structures are constructed extensions to structures in place or are joined to existing structures, the construction shall include all work necessary to provide a proper connection between the new structure and the existing as indicated on the plans.

(5) **Sewer Connections and Stub Ends.** Connections of pipe to existing storm sewers or appurtenance shall be as shown on the plans or as directed by the Engineer. The bottom of the existing structure shall be mortared or concreted if necessary, to eliminate any drainage pockets created by the new connection. Where the storm sewer is connected into existing structures which are to remain in service, any damage to the existing structure resulting from making the connection shall be restored by the Contractor to the satisfaction of the Engineer. Stub ends, for connections to future work not shown on the plans, shall be sealed by installing watertight plugs into the free end of the pipe.

(6) **Backfilling.** Backfilling for the polyethylene pipe structure is a critical phase of the construction and shall be in accordance with Item 400, "Excavation, Trenching and Backfilling". Backfill consists of a cohesionless material, such as sand, crushed stone, or gravel, and having a maximum size not to exceed 1 1/2 inch [38 mm]. The backfill material shall be placed along both sides of the completed structure(s) to a depth of 12 inches [305 mm] above the pipe. The backfill shall be placed in uniform layers not exceeding 6 inches [152 mm] in depth (loose measurement), wetted if required, and thoroughly compacted between adjacent structures and between the structure and the sides of the trench. Until a minimum cover of 12 inches [305 mm] is obtained, only hand operated tamping equipment will be allowed within vertical planes 2 feet [610 mm] beyond the horizontal projection of the outside surfaces of the structure.

(7) **Protection of Pipe.** Unless otherwise known on the plans or permitted in writing by the Engineer no heavy earth moving equipment will be permitted to haul over the structure until a minimum of 4 feet [1.2 m] of compacted fill (permanent or temporary) has been placed over the top of the structure.

Prior to adding each new layer of loose backfill material, until a minimum of 12 inches [305 mm] of cover is obtained, an inspection will be made of the inside periphery of the structure for local or unequal deformation caused by improper construction methods. Evidence of such deformation will be reason for such corrective measures as may be directed by the Engineer. Pipe deflections thirty days after final backfill shall not exceed the following values:

Pipe Diameter [mm]	Pipe Deflection [mm]
18" [450]	1" [25.4]
24" [600]	1.25" [31.75]
30" [750]	1.50" [38.10]
36" [900]	1.75" [44.45]

Pipe damaged by the Contractor shall be removed and replaced by the Contractor at no additional cost to the City of San Antonio.

MEASUREMENT:

Storm drainage pipe will be measured by the lineal foot [meter] of pipe of the various sizes, regardless of strengths involved, as measured along the centerline of the pipe in place, from inside wall of structure to inside wall of structure, or as shown on the plans. Pipe will not be classified as to strength. Trunkline pipe will be classified as to depth from the natural ground before construction begins to the invert of the pipe. Laterals, so designated on the plans, will be classified as to size but not by depth.

PAYMENT:

Storm drainage culvert pipe will be paid for at the contract unit price bid per linear foot [meter] complete in place for the type and size constructed. Trunkline pipe will be classified as to depth for payment. Lateral pipes, so designated on the plans, will not be classified as to depth for payment. Said price shall be full compensation for furnishing, hauling and placing of the pipe at locations and on the grades indicated on the plans, for all excavation and backfilling, connections to existing structures, capping end of pipe where indicted, and all other items of labor, equipment, materials, tools and incidentals necessary to complete the work in accordance with the plans and specifications. Subgrade filler if required will be paid for under Item 410, "Subgrade Filler". Depths of cut for payment will be measured from the top of ground prior to beginning of construction and along the centerline of pipe to the invert of the pipe.

PAY ITEM:

Item 402.1: Corrugated polyethylene pipe per linear foot [meter] (per depth of cut).

Item 402.2: Corrugated polyethylene pipe laterals - per linear foot [meter].

Item 402.3: Bends per each.

HIGH DENSITY CORRUGATED POLYETHYLENE PIPE HEIGHT OF COVER TABLES H-20 AND E-80 LOADS

Nominal Diameter Inches [mm]	Minimum Cover Inches [mm]		Maximum Cover Feet [m]
	H-20	E 80	
18 [450]	12 [305]	24 [610]	62 [18.9]
24 [600]	12 [305]	24 [610]	61 [18.6]
30 [750]	12 [305]	24 [610]	61 [18.6]
36 [900]	12 [305]	24 [610]	61 [18.6]

ITEM 403
STORM SEWER MANHOLES AND JUNCTION BOXES

This item shall govern for the construction of manholes and junction boxes complete in place or to the stage detailed on the plans and the materials used therein, including the installation, but not the furnishing of frames, grates, rings and covers.

TYPES: The various types of manholes and junction boxes are designated on the plans by letter or by numbers indicating the particular design of each. Each type shall be constructed in accordance with the details shown on the plans and to the depth required by the profiles and schedules given.

STAGES OF CONSTRUCTION:

All types of manholes and junction boxes shall be built complete in two stages hereinafter described as Stage I Construction and Stage II Construction.

1. Stage I Construction shall consist of that portion of manholes and junction boxes designated as such on the plans. Only that portion of the total depth included in Stage I Construction as designated on the plans shall be constructed under Stage I Construction.

2. Stage II Construction shall consist of that portion of the complete manholes or junction box not covered under Stage I. This shall include the remaining manholes height and top of manhole or junction box including the installation of rings and covers.

MATERIALS:

1. Concrete: All concrete shall conform to the provisions of Item 300, "Concrete (Class A)".

2. Reinforcing Steel: All reinforcing steel shall conform to the provisions of Item 301, "Reinforcing Steel".

3. Membrane Curing Compound: All membrane curing compound shall conform to the provisions of Item 305, "Membrane Curing".

4. Cast Iron Castings: All cast iron castings shall conform to Item 409, "Cast Iron Castings".

5. Precast Reinforced Concrete Manhole Sections: All precast reinforced concrete manhole sections shall conform to the requirements of ASTM C-478. The precast sections shall have either tongue and groove joints or dove tail joints.

6. Mortar: Mortar shall be composed of one part of Portland Cement and not more than two parts of clean sharp mortar sand.

7. Plastic Joints: Plastic joints for reinforced concrete manhole sections shall conform to Item 401, "Storm Drainage Pipe".

8. Throat Rings: Adjustment throat rings shall be non-reinforced concrete rings having a maximum thickness of 2 inches [50 mm]. The internal diameter shall not be less than 24 inches [610 mm] and the width shall be a minimum of 5 inches [127 mm]. Concrete shall conform to the provisions of Item 300, "Concrete (Class "A").

CONSTRUCTION METHODS:

1. Stage I: All concrete work shall be performed in accordance with the requirements of Item No. 307, "Concrete Structures", unless otherwise specified. Forms will be required for all concrete walls, except where the nature of surrounding material is such that it can be trimmed to a smooth vertical face. Pre-cast manholes and structures may be used upon approval by the Engineer.

2. Stage II: Precast reinforced concrete manhole sections either shall be jointed tight and sealed with stiff mortar, so placed as to form a durable watertight joint, or shall be jointed with plastic joints as follows:

Plastic joints shall be made with Cold Applied, Plastic Asphalt Sewer Joint Compound or Cold Applied Preformed Plastic Gaskets meeting the requirements as set forth in Item 401, "Storm Drainage Pipe". Application of the jointing material and construction methods shall be strictly in accordance with the manufacturer's recommendations.

MEASUREMENT:

1. Stage I: All manholes and junction boxes satisfactorily completed in accordance with Item No. 300, "Concrete (Class A)" and Item No. 301, "Reinforcing Steel".

2. Stage II: All manholes and junction boxes satisfactorily completed in accordance with the plans and specifications will be measured by the vertical foot [meter] from the top of Stage I Construction to the top of the manhole ring.

3. Cast Iron Castings will be measured in accordance with Item 409, "Cast Iron Castings".

PAYMENT:

1. Stage I: Payment for Stage I Construction of "Storm Sewer Manholes and Junction Boxes" will be paid for in accordance with Item 300, "Concrete (Class A)" and Item 301, "Reinforcing Steel". Precast manholes and structures will be paid for as if poured in place.

2. Stage II: Payment for Stage II Construction of "Storm Sewer Manholes and Junction Boxes" will be paid for at the unit price per vertical foot (meter), which price shall be full compensation for all materials, (except cast iron castings) labor, tools, equipment and incidentals necessary to complete the work. Cast iron castings will be paid for in accordance with Item 409, "Cast Iron Castings". Structural Excavation will be paid for in accordance with Item 306, "Structural Excavation".

BID ITEM:

Item 403: Storm Sewer Manholes and Junction Boxes (Stage II Construction) - per vertical foot [meter].

ITEM 406
JACKING, BORING OR TUNNELING PIPE

This item shall govern for the furnishing and installation of pipe by the methods of jacking, boring, or tunneling as shown on the plans and in conformity with this specification.

MATERIALS:

1. Pipe: Carrier Pipe shall be of the types and sizes shown on the plans and shall conform to the requirements of Item No. 401 "Storm Drainage Pipe - Jacking and Boring".

2. Liner Plate: As shown on project plans.

3. Grout: Grout for annular spaces shall be sand cement slurry containing a minimum of seven (7) sacks of Portland Cement per cubic yard of slurry. All slurry shall be plant batched and transit mixed.

CONSTRUCTION METHODS:

1. Jacking: Suitable pits or trenches shall be excavated for the purpose of jacking operations for placing end joints of the pipe. When trenches are cut in the side of embankment such work shall be securely sheeted and braced. Jacking operations shall in no way interfere with the operation of railroads, streets, highways or other facilities and shall not weaken or damage such facilities. Barricades and lights shall be furnished as directed by the Inspector to safeguard traffic and pedestrians.

The pipe to be jacked shall be set on guides to support the section of pipe being jacked and to direct it in the proper line and grade. Embankment material shall be excavated just ahead of the pipe and material removed through the pipe, and the pipe forced through the opening thus provided.

The excavation for the underside of the pipe, for at least one-third (1/3) of the circumference of the pipe, shall conform to the contour and grade of the pipe. A clearance of not more than 2 inches [50 mm] may be provided for the upper half of the pipe.

The distance that the excavation shall extend beyond the end of the pipe shall depend on the character of the material, but it shall not exceed 2 feet [610 mm] in any case.

Generally, pipe shall be jacked from the downstream end. Permissible lateral or vertical variation in the final position of the pipe from line and grade will be as shown on the plans or as determined by the Engineer.

In operating jacks, even pressure shall be applied to all jacks used. A suitable jacking head and suitable bracing between the jacks and the jacking head shall be provided so that pressure will be applied to the pipe uniformly around the ring of the pipe. Joint cushioning material of plywood or other material may be used as approved by the Engineer. Plywood cushioning material shall be 1/2 inch [13 mm] minimum thickness for pipe diameters 30 inches [750 mm] and less and 3/4 inch [19 mm] minimum thickness for pipe diameters greater than 30 inches [750 mm]. Cushioning rings may be made up of single or multiple pieces.

Any pipe damaged in jacking operations that cannot be repaired to the original pipe specification, shall be removed and replaced at the Contractor's expense.

Jacking pits shall be backfilled immediately upon completion of jacking operations.

2. Boring: Excavation for "Boring" pits and installation of shoring shall be as outlined under "Jacking". The boring may be done using a pilot hole. The pilot hole shall be bored the entire length of the crossing and shall be used as a guide for the larger hole to be bored. Water or drilling fluids may be used to lubricate cuttings.

Variation in line and grade shall apply as specified under "Jacking".

3. Tunneling: Tunneling may be used when the size of the proposed pipe or the use of a monolithic sewer would make the use of tunneling more satisfactory than "Jacking" or "Boring".

The excavation for pits and the installation of shoring shall be as specified under "Jacking".

The lining of the tunnel shall be of the material shown on the plans.

Access holes for grouting annular space shall be spaced a maximum of 10 feet [3 m].

4. Joints: Joints for pipe used for "Jacking", "Boring" or "Tunneling" shall be as per the manufacturer's recommendation.

5. Grouting of Bores or Tunnels: Grouting of the annular space outside the casing shall be required when over-excavation around the casing exceeds the greater of 1 inch [25 mm] or 5% of the outside diameter of the casing pipe.

6. End Plugs - The casing shall be plugged on both ends before backfilling pits or trenches. Plugs shall consist of a minimum of 2 linear feet [610 mm] of low strength grout (1,500 psi minimum [10 MPa]) or other method approved by the engineer.

MEASUREMENT:

Jacking, Boring or Tunneling shall be measured by the linear foot [meter] of bore or tunnel from station to station as shown on the plans.

Carrier pipe used in bores and tunnels or jacked into place shall be measured by the linear foot [meter] of pipe installed from end to end of pipe to the limits shown on the plans.

Casings or liners, where required by the plans, of the size and material required, shall be measured by the linear foot [meter] actually installed in accordance with the plans.

PAYMENT:

The work performed and materials furnished as specified herein, measured as provided above shall be paid for at the contract unit price bid per linear foot [linear meter] of jacking, boring or tunneling, which price shall be full compensation for furnishing all materials (except carrier pipe, casings or liners), labor, tools, equipment and incidentals necessary to complete the work, including excavation, grouting, backfilling, restoration to original ground conditions and disposal of surplus material.

Carrier pipe shall be paid for at the contract unit price bid for "Carrier Pipe for Jacking, Boring or Tunneling" per linear foot [meter] of pipe installed and measured as prescribed above.

Casings or liners shall be paid for at the contract unit price bid for "Casing or Liner" per linear foot [meter] of casing or liner installed and measured as prescribed above.

BID ITEM:

Item 406.1: Jacking, Boring or Tunneling - per linear foot [meter].

Item 406.2: Carrier pipe for Jacking, Boring or Tunneling per linear foot [meter].

Item 406.3: Casing or Liner - per linear foot [meter].

ITEM 407
CONCRETE ENCASEMENT, CRADLES, SADDLES AND COLLARS

This item shall govern for placing concrete encasements, cradles, saddles and collars, when called for by the Project plans or as directed by the Engineer.

MATERIALS:

Concrete: All concrete shall conform to the provisions of Item No. 300, "Concrete (Class B)" or shall be of the class as noted on the plans.

CONSTRUCTION METHODS:

1. Concrete Encasement: When concrete encasement is shown on the plans or when directed by the Engineer, the trench shall be excavated and fine graded to a depth conforming with details and sections shown on the plans. The pipe shall be supported by precast concrete blocks of the same strength as the concrete for encasement and securely tied down to prevent floatation. Encasement shall then be placed to a depth and width conforming with details and sections shown on the plans.

2. Concrete Cradles: When concrete cradles are shown on the plans or when called for by the Engineer the trench shall be prepared and the pipe supported in the same manner as described in concrete encasement of this specification and shall be constructed in accordance with details and sections shown on the plans.

3. Concrete Saddles: When shown on the plans or when directed by the Engineer, pipe to receive concrete saddles shall be backfilled in accordance with Item No. 400, "Excavation, Trenching and Backfill" to the spring line and concrete placed for a depth and width conforming with details and sections shown on the plans.

4. Concrete Collars: When shown on the plans or when directed by the Engineer concrete collars shall be constructed in accordance with details and sections shown on the plans.

MEASUREMENT: "Concrete Encasement, Cradles, Saddles, and Collars", will be measured by the cubic yard [cubic meter] of accepted work, complete in place.
Reinforcing, if required, shall not be measured for payment.

PAYMENT: "Concrete Encasement, Cradles, Saddles and Collars" will be paid for at the unit price bid per cubic yard [cubic meter], which price shall be full compensation for furnishing and placing all materials, manipulation, labor, tools, equipment and incidentals necessary to complete the work.

BID ITEMS:

Item 407.1: Concrete Encasement - per cubic yard [cubic meter]

Item 407.2: Concrete Cradles - per cubic yard. [cubic meter]

Item 407.3: Concrete Saddles - per cubic yard. [cubic meter]

Item 407.4: Concrete Collars - per cubic yard. [cubic meter]

ITEM 409
CAST IRON CASTINGS

This item shall govern for the furnishing and installation of frames, grates, rings and covers for inlets, storm sewer manholes and other structures in accordance with the plans and specifications.

MATERIALS: Castings shall conform to the requirements of the Standard Specifications for Gray Iron Castings, ASTM Designation A48, for Class 20 (20,000 psi [138 MPa] ultimate tensile strength) Gray Cast Iron. Castings shall be boldly filleted at angles and the arrises shall be sharp and perfect. Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength for the service intended. Bearing surfaces shall be cast with such precision or shall be so machined, that perfect bearing will be attained.

CONSTRUCTION METHODS:
Frames, grates, rings and covers shall be constructed of the materials as specified and in accordance with the details shown on the plans and shall be placed carefully to the lines or grades indicated on the plans or as directed by the Engineer.

MEASUREMENT: Cast Iron Castings will be measured by the pound [kilogram], manufacturer's catalogue weight, and shall include manhole rings and covers, grates, and frames.

PAYMENT: Payment for "Cast Iron Castings" will be made at the contract unit price bid per pound [kilogram], which unit price shall be full compensation for the completed installation.

BID ITEM:
Item 409: Cast Iron Castings - per pound [kilogram].

ITEM 410

SUBGRADE FILLER

This item shall consist of furnishing and placing materials for purposes of stabilizing subgrades in trenches or channels or under conduits or poured-in-place box culverts, bedding for pre-cast box culverts or as instructed by the Inspector, where quicksand, muck or other unstable material is encountered and the Inspector deems the measures provided herein warranted.

CLASSES: The subgrade fillers shall be of two classes known as Concrete Subgrade Filler and Gravel Subgrade Filler.

MATERIALS:

1. Concrete: Concrete subgrade filler shall be composed of concrete conforming to the provisions of Item No. 300, "Concrete (Class C)".

2. Gravel: Gravel subgrade filler shall be composed of well graded, crushed stone or gravel, approved by the Engineer, one hundred percent (100%) passing a two inch (2") sieve at least ninety-five percent (95%) passing a one and three quarter inch (1 3/4") sieve and at least ninety percent (90%) retained on a one quarter inch (1/4") sieve.

The crushed stone or gravel shall have an abrasion of not more than forty (40) when subjected to the Los Angeles Abrasion Test.

CONSTRUCTION METHODS: Where the soil encountered in the subgrade for a channel bottom, a box culvert, box conduit, storm sewer, or other structure at established footing or pipe bearing grade is a quicksand, muck, or other unstable material, the Inspector may order its removal to any depth deemed necessary and replacement with one of the fillers specified above. Where so ordered by the Inspector, the following procedures shall govern:

1. The concrete subgrade filler will be used to establish a thin working surface on subgrades which are saturated but are regarded as stable, and where otherwise the construction operations would disturb the subgrade surface. In such a case a layer of material to a depth below the established footing or bearing elevation, as directed, shall be removed and replaced with the concrete filler material, the material shall be lightly consolidated by tamping and the surface shall be screeded or struck off and allowed to set to form a subgrade surface of accuracy equivalent to that obtained for normal fine grading of subgrade.

2. Gravel subgrade filler will be used to replace wet subgrade or other unstable materials regarded as unsatisfactory for support of the structure involved. In such cases, subgrade material shall be removed to such depth below the established footing or bearing elevation as may be ordered. The soil removed shall be replaced with gravel or crushed stone as subgrade filler, placed in uniform layers of suitable depth, as directed by the Inspector. Graded subgrade filler also will be used for bedding for precast box culverts and initial backfill material for flexible pipe and in rock construction.

MEASUREMENT: Each class of subgrade filler, in place in accordance with these specifications, complete and accepted, will be measured for payment by the cubic yard [cubic meter] of material in place.

PAYMENT: Payment for the subgrade fillers will be made at the contract unit price bid respectively for "Concrete Subgrade Filler", or for "Gravel Subgrade Filler", as the case may be. Such prices shall include full compensation for removal and disposal of materials below the established subgrade levels and the furnishing and placing of the subgrade filler materials.

BID ITEMS:

Item 410.1: Concrete Subgrade Filler - per cubic yard [cubic meter].

Item 410.2: Gravel Subgrade Filler - per cubic yard [cubic meter].

DIVISION V

INCIDENTAL CONSTRUCTION

ITEM 500
CONCRETE CURBING

This item shall govern for installation of Portland cement concrete curbing with or without reinforcing steel as required, construction on an approved subgrade or base in accordance with this specification and in conformity with the lines, grades, section and details shown on the plans, or as established by the Engineer.

MATERIALS:

1. Concrete: All concrete shall conform to the provisions of Item 300, "Concrete (Class A)" or shall be of the class as noted on the plans.

2. Reinforcing Steel: All reinforcing steel shall conform to the provisions of Item 301, "Reinforcing Steel".

3. Expansion Joint Materials: All expansion joint materials shall conform to the provisions of Item 304, "Expansion Joint Materials".

4. Membrane Curing Compound: All membrane curing compound shall conform to the provisions of Item 305, "Membrane Curing".

CONSTRUCTION METHODS:

Subgrade for curbing shall be excavated so as to have a cushion, a minimum of 2 inches [50 mm] thick of crusher screenings, gravel or crushed rock, which shall be spread, wetted and thoroughly tamped. If dry, the cushion shall be sprinkled lightly before concrete is deposited thereon. Where the subgrade is rock, or gravel, 70% of which is rock, the 2 inch [50 mm] cushion need not be used. The Inspector will determine if the subgrade meets the above requirement.

If the subgrade is undercut, or the natural ground is below "top of subgrade", the necessary backfill shall be made with an approved material and compacted with a mechanical tamper. Hand tamping will not be permitted.

Forms shall be of metal or well-seasoned wood. Forms shall be clean, straight and free from warp and of the depth required. All forms shall be securely staked to line and grade and maintained in a true position during the depositing of concrete. The inside forms shall be rigidly attached to the outside forms. Before concrete is placed, all forms shall be oiled with a light form oil.

The reinforcing steel, if required shall be placed in position as shown on the typical section. Care shall be exercised to keep all steel in its proper location.

Expansion joint material shall be provided at intervals not to exceed 50 feet [15 m], and shall extend the full width and depth of the concrete. Templates for "dummy" joints shall be of steel, not less than 3/16 of an inch [5 mm] in thickness and patterned to the shape of the curb. Templates shall be cleaned and oiled and spaced to cut the curb in sections 10 feet [3 m] in length. The templates shall extend a distance of 8 inches [203 mm] into the curb from the top down.

Two round smooth dowel bars 3/8 of an inch [10 mm] in diameter and 18 inches [457 mm] in length shall be installed at each expansion joint. One 9 inch [229 mm] end of each dowel shall be thoroughly coated with hot oil asphalt so that it will not bond to the concrete; approved types of slip joints may be used in lieu of coating ends of dowels. The dowels shall be placed on the vertical centerline 3 inches [76 mm] from the top and bottom.

Concrete shall be placed in the forms, rodded and tamped to exclude all air and honeycomb. After the concrete has become sufficiently set, the exposed edges shall be rounded by the use of an edging tool to the radii indicated on the plans. After the inside form has been removed, the surface shall be dusted with a dust consisting of one (1) part "Portland Cement" and two (2) parts fine sand. The entire exposed surface of the curb shall be floated to a uniform smooth surface then finished with a camel hair brush or wood float to a gritty texture. It is not permissible to plaster curb where forms have stayed on over night. The forms must be removed and the curb finished monolithic the same day as concrete is poured.
Immediately after finishing the curb, it shall be protected by a membrane-compound curing agent.

The curb shall be backfilled to the full height of the concrete, tamped and sloped as directed by the Inspector. The top 4 inches [102 mm] of fill shall be of clean top soil, free of stones and debris.

MEASUREMENT:

Accepted work as prescribed by this item will be measured by the linear foot [meter] of concrete curb, complete in place.

PAYMENT:

The work performed as prescribed by this item will be paid for at the contract unit price bid per linear foot [meter] for 'Concrete Curbing', which price shall be full compensation for preparing the subgrade, for furnishing and placing all materials, including reinforcing steel, all expansion joint material, curing and for any other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work. Topsoil to be paid under Item 515, "Topsoil".

BID ITEM

Item 500: Concrete Curbing - per linear foot [meter].

ITEM 501
MACHINE LAID CURB

This item shall govern the installation of Portland Cement concrete curb, constructed on an approved base in accordance with this specification and in conformity with the lines, grades, sections and details shown on the plans or as established by the Engineer.

MATERIALS:

1. Concrete: All concrete shall conform to the provisions of Item 300, "Concrete (Class A)".

2. Expansion Joint Material: All expansion joint material shall conform to the provisions of Item 304, "Expansion Joint Materials'.

3. Membrane Curing Compound: All membrane curing compound shall conform to the provisions of Item 305, "Membrane Curing".

CONSTRUCTION METHODS:

The base required between the curbs shall be extended to a line designated on the typical sections and details.

The curb shall be laid by a curbing extrusion machine approved by the Engineer. The line for top of curb shall be maintained from a guide-line or guide-rails set by the Contractor from survey marks established by the Consultant . Curb outline shall strictly conform to the details shown on the plans. The forming tube of the extrusion machine shall be readily adjustable vertically during the forward motion of the machine, to provide required variable height of curb necessary to conform to the established grade line. If a guideline is used, a pointer or gauge shall be attached to the machine in such a manner that a comparison can be made between the curb and the guideline in order to provide a continual check on the curb grade. Other methods may be used if approved by the Engineer.

The concrete shall be fed into the machine in such a manner and at such consistency that the finished curb will present a well compacted mass with a surface free from voids and honeycomb and true to established shape, line and grade.

Immediately following extrusion any voids between the trench walls and curb shall be filled with well compacted concrete and finished off flush with the surface of the base.

Any additional surface finishing specified and/or required shall be performed immediately after the above void-filling operation. 'Dummy' joints shall be cut to a depth of 1/2 inch (13 mm) at 10 foot (3 m) intervals or as directed by the Inspector.

Whenever the curb end abuts a concrete structure a 1/2 inch (13 mm), premolded, expansion joint, conforming to the curb section, shall be placed between the two concrete surfaces.

Whenever extrusion is suspended long enough to produce a cold joint, 3/8 inch [10 mm] smooth dowel bars, 18 inches [457 mm] long, shall be embedded 9 inches [229 mm] into the completed curb, one-quarter (1/4) curb height from top and bottom. The end of the curb at the point of suspension of extrusion shall be cut back until all remaining concrete is of a dense well compacted nature.

Any addition of concrete to the extruded curb is to be applied and finished before the extruded curb has achieved its initial set.

When finishing operations are completed the curb is to be coated with membrane curing compound.

When the curb has cured, it shall be backfilled to the full height of the concrete, tamped and sloped as directed by the Inspector. The top 4-inches [102 mm] of fill shall be clean top soil, free of stones and debris.

MEASUREMENT:

Machine Laid Curbs will be measured by the linear foot [meter] of completed and accepted curb, complete in place.

PAYMENT:

The work performed as prescribed by this item, will be paid for at the contract unit price bid per linear foot [linear meter] for "Machine Laid Curb", which price shall be full compensation for furnishing and placing all materials, including dowel bars and expansion joints and for all other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the

work. Top soil, 4" inches [102 mm] depth used as fill behind the curb will be paid for under Item 515 "Topsoil".

BID ITEM

Item 501: Machine Laid Curb - per linear foot [meter].

ITEM 502
CONCRETE SIDEWALKS AND DRIVEWAYS

This item shall govern for concrete sidewalks and driveways, composed of Portland Cement concrete, constructed as herein specified on an approved subgrade, in conformity to the lines, grades and details shown on the plans or as established by the Engineer.

MATERIALS:

1. Concrete: All concrete for sidewalks shall conform to the provisions of Item 300, "Concrete (Class B)". All concrete for driveways shall conform to the provisions of Item 300, "Concrete (Class A)".

2. Reinforcing Steel: All reinforcing steel shall conform to the provisions of Item 301, "Reinforcing Steel".

3. Welded wire Flat Sheets: All welded wire fabric shall conform to the provisions of Item 303, "Welded Wire Flat Sheets".

4. Expansion Joint Materials: All expansion joint materials shall conform to the provisions of Item 304, "Expansion Joint Materials".

5. Membrane Curing Compound: All membrane curing compound shall conform to the provisions of Item 305, "Membrane Curing".

6. Exposed aggregate sidewalks: Natural Aggregate: All natural aggregate (fine and coarse) shall be obtained from a "Medina River Source" or other similar source. These aggregates shall be of a tan to brown color so as to impart an "earth-tone" color. Samples of the aggregates shall be submitted prior to construction for approval by the City.

CONSTRUCTION METHODS:

The subgrade shall be excavated and shaped to the lines, grades and cross section shown on the plans, or as directed by the Engineer, and shall be thoroughly compacted. A cushion, 2 inch [50 mm] minimum thickness, of crusher screenings, gravel , crushed rock or flex base material shall be spread, wetted thoroughly, tamped and leveled. The cushion shall be moist at the time the concrete is placed. If the subgrade is undercut, or the natural ground is below "top of subgrade" then necessary backfill shall be made with approved material and compacted with a mechanical tamper. Hand tamping will not be permitted.

Where the subgrade is rock or gravel, 70% of which is rock, the 2 inch [50 mm] cushion need not be used. The Inspector will determine if the subgrade meets the above requirement. Forms shall be of metal or well-seasoned wood of a section satisfactory to the Inspector; clean, straight, free from warp, and of a depth equal to the thickness of the finished work. All forms shall be securely staked to line and grade maintained in a true position during the depositing of concrete. Before concrete is placed, forms shall be thoroughly oiled with a light form oil.

Expansion joint material, 1/2 inch thick [13 mm], shall be provided at intervals not to exceed 50 feet [15 m] and where the new construction abuts the existing curbs or driveways if the Inspector deems it necessary. The expansion joint material shall be placed vertically and shall extend the full depth and width of the concrete.

A minimum of two (2) round smooth dowel bars 3/8 inchs [10 mm] in diameter and 18 inches [457 mm] in length shall be spaced 18 inches [457 mm] apart at each expansion joint. Nine inchs [229 mm] of each dowel shall be thoroughly coated with hot oil asphalt or greased, so that it will not bond to the concrete. Approved types of slip joints may be used in lieu of coating ends of dowels.

Sidewalks shall be marked with transverse "dummy" joints as shown on detail sheets , by the use of approved jointing tools.

Concrete sidewalks and driveways shall be reinforced as shown on the plans. Reinforcement for sidewalks shall consist of either one (1) layer of 6"x6" - W2.9 x W2.9 welded wire flat sheets or No. 3 (3/8") [10 mm] reinforcing steel, placed not more than 18 inches [457 mm] on centers both directions. Reinforcement for driveways shall consist of either one layer of 6"x6" - W5xW5 welded wire flat sheet or No. 3 (3/8") [10 mm] reinforcing steel placed not more than 12 inches [305 mm] on centers both directions. All reinforcement shall be placed equidistant from the top and bottom of the concrete. Care shall be exercised to keep all steel in its proper position during the depositing of concrete. Splices in wire fabric shall conform with the requirements set forth in Item 303, "Welded Wire Flat Sheets". Splices in the No. 3 bars shall have a minimum lap of 12 inches (305 mm) .

Reinforcing for commercial driveways shall consist of either one (1) layer of 6"x6" - W10 x W10 welded wire

flat sheets or No. 4 (1/2") [12 mm] reinforcing steel placed not more than 12 inches [457 mm] on center both directions. The Concrete slab will be a minimum of 6 inches [152 mm] thick or as shown on the plans.

Concrete shall be placed in the forms and spaded, tamped and thoroughly compacted until mortar entirely covers the surface and has a monolithic finish. The top surface shall be floated and troweled to a uniform smooth surface, then finished with a camel hair brush or wood float to a gritty texture. The outer edges and joints shall be rounded with approved tools to the radii shown on the plans.

Finish for Exposed Aggregate Sidewalks: Wash concrete surface after initial set with staff bristle brush and water to remove matrix and clean each piece of exposed coarse aggregate. Unless otherwise acceptable to the Inspector, perform washing and brushing 3-4 hours after casting. Care shall be taken to uniformly expose about a third of each piece of coarse aggregate, removing no more of the matrix than necessary to achieve a uniform exposure of coarse aggregate across the panel surface and as required to achieve appearance similar to adjacent existing work. After seven days, follow with a final cleaning with a mild acid solution and a final rinsing with clear water.

Immediately after finishing, the surface shall be protected by a membrane curing compound, or by wetted cotton or burlap mats. Either method shall be subject to approval by the Inspector.

All necessary excavation for the sidewalk section , will be considered incidental work pertaining to this item, and will not be paid for directly. The adjacent excavation and grading of the slopes shall he done in a manner acceptable to the Inspector.

MEASUREMENT:

Accepted work performed as prescribed by this item will be measured by the square yard [square meter] of surface area of concrete.

PAYMENT:

The work performed as prescribed by this item will be paid for at the contract unit price bid per square yard [square meter] for "Concrete Sidewalks" or "Concrete Driveways", which price shall be full compensation for preparing the subgrade; for furnishing and placing all materials, including all reinforcing steel and expansion joint materials, and for any other materials, manipulation, labor, tools, equipment and incidentals necessary to complete the work. Filling and grading of the slopes, adjacent to the completed concrete sidewalks and/or driveways will be paid as subsidiary work under Item 104, "Excavation".

BID ITEMS:

Item 502-1: Concrete Sidewalks - per square yard [square meter].

Item 502-2: Concrete Driveway - per square yard [square meter].

Item 502-3: Commercial Driveway - per square yard [square meter].

Item 502.4: Exposed Aggregate Sidewalk - per square yard [square meter].

ITEM 503
ASPHALTIC CONCRETE AND GRAVEL DRIVEWAYS

This item shall govern for asphaltic concrete and/or gravel surfaced driveways constructed in accordance with these specifications and in conformity to the lines, grades and details shown on the plans or as established by the Engineer.

MATERIALS:

1. Flexible Base: All flexible base shall conform to the provisions of Item No. 200, "Flexible Base".

2. Prime Coat: All prime coat shall conform to the provisions of Item No. 202, "Prime Coat".

3. Tack Coat: All tack coat shall conform to the provisions of item No. 203, "Tack Coat".

4. Hot Mix Asphaltic Concrete Pavement: All hot mix asphaltic concrete pavement shall conform to the provisions of item No. 205, "Hot Mix Asphaltic Concrete Pavement".

CONSTRUCTION METHODS:

The subgrade shall be excavated to a minimum depth of 7 inches [178 mm] for asphaltic concrete driveways and 6 inches [152 mm] for gravel driveways, below the finished grade of the driveway, and shaped to the proper line and cross-section as shown on the plans or as directed by the Engineer, wetted if required and thoroughly compacted. If the subgrade is undercut, or the natural ground is below "top of subgrade", the necessary backfill shall be made with flexible base, or approved material as directed by the Inspector.

Flexible base shall be placed so that the compacted depth will be a minimum of 6 inches [152 mm]. The base shall be wetted as required and compacted to an apparent dry density, of not less than 90 percent of the maximum dry density as determined by the Texas Highway Department Test Method Tex 113-E. The surface of the compacted base shall be smooth and in conformity with typical sections and to the established lines and grades.

If the driveway is to receive asphaltic concrete pavement, it shall be prime coated with an approved sprayer, at a rate not to exceed 0.20 gallons per square yard [0.90 liters per square meter] of surface. The tack coat shall be applied at a rate not to exceed 0.10 gallons per square yard [0.45 liters per square meter], or as directed by the Inspector.

Hot mix asphaltic concrete pavement shall be applied at a rate of 165 pounds per square yard [90 kilograms per square meter] and compacted thoroughly and uniformly with approved rolling or tamping equipment. The finished asphalt surface shall be smooth and true to the established line and grades.

All necessary excavation and grading of the slopes, adjacent to the completed asphalt or gravel driveways, will be considered incidental work pertaining to this item, and will not be paid for directly. The adjacent excavation and grading of the slopes shall be done in a manner acceptable to the Inspector.

MEASUREMENT:

No separate measurement of excavation, base material, prime coat, tack coat or asphalt surfacing will be made. Accepted work as prescribed by this item will be measured by the square yard [square meter] of asphaltic concrete driveway or gravel driveway.

PAYMENT:

The work performed as prescribed by this item will be paid for at the contract unit price bid per square yard [square meter] for "Asphaltic Concrete Driveway" or "Gravel Driveway", which price shall be full compensation for preparing the subgrade, for furnishing and placing all materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

BID ITEM

Item 503-1: Asphaltic Concrete Driveway per square yard [square meter].

Item 503-2: Gravel Driveway - per square yard [square meter].

ITEM 504
CONCRETE MEDIANS AND ISLANDS

This item shall consist of traffic islands and medians composed of Portland Cement Concrete, constructed in accordance with these specifications and in conformity to the lines, grades, sections and details shown on the plans or as established by the Engineer.

MATERIALS:

1. Concrete: All concrete shall conform to the provisions of Item 300, "Concrete (Class B)" or shall be of the class as noted on the plans.

2. Reinforcing Steel: All reinforcing steel shall conform to the provisions of Item 301, "Reinforcing Steel".

3. Welded Wire Flat Sheets: All-welded wire fabric shall conform to the provisions of Item 303, "Welded Wire Flat Sheets".

4. Expansion Joints Materials: All expansion joint materials shall conform to the provisions of Item 304, "Expansion Joint Materials".

5. Membrane Curing Compound: All membrane curing compound shall conform to the provisions of Item 305, "Membrane Curing".

CONSTRUCTION METHODS:

Forms shall be of metal or well-seasoned wood. Forms shall be of a section satisfactory to the Inspector, clean, free from warp and of a depth equal to the finished work. All forms shall be securely staked to line and grade and maintained in a true position during the depositing of concrete. Before concrete is placed, forms shall be thoroughly oiled with a light form oil. Subgrade, and/or cushion if used, for Concrete Islands or Medians shall be as specified on the plans. If the adjacent existing asphalt pavement is damaged it shall be restored to its original condition.

Reinforcement shall conform to the details shown on the plans or the directions of the Engineer. Care shall be exercised to keep reinforcement in its proper position during the depositing of concrete.

Concrete shall be placed in the forms to the depth indicated on the plans and spaded, tamped or vibrated until thoroughly compacted and until mortar entirely covers the surface and forms a monolithic finish.

If a vibrator is used, care shall be taken not to leave it in one location long enough to induce segregation. The top surface shall be floated and troweled to a uniform smooth surface, then finished with a camel hair brush or wood float to a gritty texture. The outer edges shall be rounded with approved tools to the radii shown on the plans.

Immediately after finishing the concrete island or median, the surface shall be protected by a membrane curing compound of a type acceptable to the Engineer. Where premolded expansion joint material is specified on the plans, the top 1 inch [25 mm] of the premolded expansion joint material shall be cut and stripped out and filled with satisfactory elastic filler approved by the Engineer.

MEASUREMENT:

Accepted work as prescribed by this item will be measured by the square yard [square meter] of surface area of concrete island or median, complete in place.

PAYMENT:

The work performed as prescribed by this item will be paid for at the unit Pride bid per square yard [square meter] for "Concrete Medians and Islands", which price shall be full compensation for preparing the subgrade, and for finishing and placing all materials, including all reinforcing steel, welded wire fabric, and for any other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

BID ITEM

Item 504: Concrete Medians and Islands per square yard [square meter].

ITEM 505
CONCRETE RIP RAP

This item shall govern for cast in place concrete riprap, furnished in accordance with the details, sections, lines and grades shown on the plans, reinforced as shown thereon, complete with respect to all materials and workmanship in accordance with these specifications.

MATERIALS:

1. Concrete: All concrete shall conform to the provisions of Item 300, "Concrete (Class A)" or shall be of the class as noted on the plans.

2. Reinforcing Steel: All reinforcing steel shall conform to the provisions of Item 301, "Reinforcing Steel".

3. Welded Wire-Flat Sheets: All welded wire fabric shall conform to the provisions of Item 303, "Welded Wire Flat Sheets".

4. Expansion Joint Materials: All expansion joint materials shall conform to the provisions of Item 304, "Expansion Joint Materials'.

5. Membrane Curing Compound: All membrane curing compound shall conform to the provisions of Item 305, "Membrane Curing'.

CONSTRUCTION METHODS:

The concrete riprap shall be reinforced as shown on the plans. All reinforcements, including dowels, shall be properly and adequately supported throughout the placement of concrete. Dowel bars or reinforcement protruding from existing riprap shall be thoroughly cleaned.

All earthen surfaces on which the riprap is to rest shall be accurately excavated and graded to provide a firm bedding for the riprap. If the slopes and bottom of the trench for toe walls are dry and not consolidated properly, the Inspector may require the entire area to be sprinkled, or sprinkled and consolidated before the concrete is placed. All surfaces shall be moist when concrete is placed. It is the intent that the finished surface of the riprap be a continuation of the finished surface of the channel or embankment which it is to protect. All excavation for toe walls shall, to the extent practicable, be made to the neat lines of the concrete sections.

The new riprap shall be doweled into all concrete that abuts it, both new and existing. Weep holes and graded fill shall be constructed as shown on the plans or as directed by the Engineer.

Expansion joint material, 1/2 inch [13 mm] thick, shall be provided where the new construction abuts existing construction as the Inspector deems it necessary. The expansion joint material shall be placed vertically and shall extend the full depth of the concrete. Similar expansion material shall be placed around all obstructions protruding through the concrete riprap.

After the concrete has set sufficiently to avoid slumping, the surface shall be finished with a wooden float to a smooth and uniform finish, and exposed edges shall be tooled. Immediately after finishing the riprap, the surface shall be protected by a membrane curing compound.

If the Contractor so elects, an air entraining admixture, approved as to brand and quality, may be employed to facilitate the placement and finish of the riprap. The entrained air range shall be from 3 to 6 percent.

MEASUREMENT:

Accepted work as prescribed by this item will be measured by the square yard [square meter] of concrete riprap, complete in place. The area measured for payment will be exposed finished surface which will include all vertical, horizontal and sloping surfaces. Toewalls shall not be measured and are included in the surface measurement of the riprap they protect.

PAYMENT:

The work performed as prescribed by this item, will be paid for at the contract unit price bid per square yard [square meter] for "Concrete Riprap", which price shall be full compensation for all required excavation, weep holes, graded fill, reinforcing, expansion joint material, dowels, curing and all other materials, labor, and incidentals necessary to complete the work.

Payment for excavation of toewall trenches and for all necessary excavation below natural ground or bottom of excavated channel will be included in the unit price bid per square yard [square meter]of riprap.

BID ITEM

Item 505: Concrete Riprap - per square yard - [square meter]__ inches [mm] thick.

ITEM 506
CONCRETE RETAINING WALL - COMBINATION TYPE

This item shall govern for retaining walls composed of Portland Cement Concrete, constructed on a specially doweled sidewalk as herein specified, in conformity with the lines, grades and details shown on the plans or as established by the Engineer. (Item No. 502, "Concrete Sidewalks & Driveways" is hereby referenced and made a part of this specification.)

MATERIALS:

1. Concrete: All concrete shall conform to the provisions of Item 300, "Concrete (Class A)" or shall be of the class as noted on the plans.

2. Reinforcing Steel: All Reinforcing steel shall conform to the provisions of Item 301, "Reinforcing Steel".

3. Expansion Joint Materials: All expansion joint materials shall conform to the provisions of Item 304, "Expansion Joint Materials'.

4. Membrane Curing Compound: All membrane curing compound shall conform to the provisions of Item 305, "Membrane Curing".

5. Exposed Aggregate Retaining Walls: Natural Aggregate: All natural aggregate (fine and coarse) shall be obtained from a "Medina River Source" or other similar source. These aggregates shall be of a tan to brown color so as to impart an "earth-tone" color. Samples of the aggregates shall be submitted prior to construction for approval by the City.

CONSTRUCTION METHODS:

All excavation shall be done in accordance with Item 502, "Concrete Sidewalks and Driveways" and no direct payment shall be made.

All forms and forming, placement of reinforcement, placement of concrete, form removal, finishing and curing shall conform to the provisions of Item 307, "Concrete Structures".

The height of the wall will be determined by conditions on the ground, and shall be such that water will not be trapped on private or public property.

Reinforcement for the wall shall be as shown on the plans and all expansion joints shall extend the full height and width of the wall.

The contractor shall provide dowel bars of the proper size, shape and spacing to tie the walk and wall together, as shown on the plans. The walk shall also be widened sufficiently so that the wall can be poured on the widened portion of the walk.

Finish for exposed aggregate retianing walls shall conform to the requirements of Item 502, "Concrete Sidewalks and Driveways".

MEASUREMENT:

Accepted work as prescribed by this item will be measured by the cubic yard [cubic meter], complete in place. Sidewalk construction with retaining wall will not be paid for under this item, but shall be paid for under Item 502, "Concrete Sidewalks and Driveways". Included for payment as sidewalk shall be that portion under the retaining wall.

PAYMENT:

The work performed as prescribed by this item will be paid for at the contract unit price bid per cubic yard [cubic meter] for "Concrete Retaining Wall - Combination Type", which price shall be full compensation for all excavation, forms, concrete, reinforcement, curing, backfilling, sloping, and for all labor, tools, materials, equipment and incidentals necessary to complete the work.

BID ITEM

Item 506: Concrete Retaining Walls - Combination Type - per cubic yard [cubic meter].

Item 506.2: Exposed Aggregate Retaining Walls - combination type - per cubic yard [cubic meter].

ITEM 507
CHAIN LINK WIRE FENCE

This item shall govern for chain link fabric supported on posts and with bracing and accessories as shown in the plans or as specified herein, erected complete in place as shown in the plans or as directed by the inspector.

MATERIALS:

1. Fabric: Fabric shall consist of steel wires of a gauge as shown on the plans and shall be woven with 2-inch [50 mm] mesh openings such that in a vertical dimension of 23 inches [584 mm] along the diagonals of the openings there shall be at least seven meshes. The top and bottom selvages shall have a twisted and barbed finish, the barbing to be done by cutting the wire at an angle to create sharp points. The wire in the fabric shall have a tensile strength of not less than 75,000 pounds per square inch [517 107 kPa], after galvanizing or aluminum coating is applied. Fabric shall conform to the least requirements of the ASTM A 392, Class 1, or ASTM A 491.

2. Top Rail: Top rails shall be tubular steel of the diameter and weight per linear foot as shown on the plans. Rails shall be galvanized inside and out. Sleeves shall be outside sleeves at all joints, and shall be galvanized.

3. Tension Wire: Tension wire shall be used as indicated on the plans. The gauge shall be as shown on the plans and the wire shall be of coil spring steel of good commercial quality and shall be galvanized.

4. Tie wires: Wire for attaching fabric to tension wire and to top rail shall be not less than No. 12 gauge galvanized wire, or fastenings in accordance with the manufacturer's standard design. Sufficient fastening material shall be furnished to provide for attaching the fabric to the tension wire and to the top rail and posts at spacings shown on the plans.

5. Line Posts: Line posts shall be tubular steel and of a diameter and weight per linear foot [meter] as shown on the plans, and shall be galvanized inside and out. Line posts shall be fitted with galvanized watertight malleable iron caps which permit the top rail to pass through the top cap and which provide a tight fit over the outside of the post.

6. Corner, Tension, Terminal and Gate Posts: Corner, tension, terminal and gate posts shall be of tubular steel of the diameter and weight per linear foot [meter] as indicated on the plans, and shall be galvanized inside and out. Such posts shall be furnished with all accessories, braces and fittings of pressed or rolled steel, forged steel or malleable iron, all galvanized, as required for complete installation, bracing, fastening, supporting, and securing the fence, top rails and tension wire. Posts shall have heavy malleable iron caps, galvanized, for closing the posts to exclude moisture. Caps shall be made to provide a driving fit over the outside of the post.

7. Braces and Cables: Braces or cables shall be installed at all corner, tension, terminal and gate posts and shall be extended to adjacent line posts, in accordance with the plans. Braces and trussing material shall be high carbon steel of good commercial quality and shall meet the dimensions and other requirements on the plans. Brace rods shall be 3/8 inch [10 mm] diameter and be equipped with turnbuckles. Cables shall be 3/8 inch [10 mm] diameter and shall be composed of seven wires. Cables shall be installed as shown on the plans, and shall include the use of 3/8 inch [10 mm], drop-forged eye-and-eye, or eye-and-clevis turnbuckles.

8. Gate frames: Gate frames shall be made of high carbon steel of good commercial quality, tubular, and shall be galvanized inside and out. Gate frames shall be filled with the same fabric as specified for the fence. All gates shall be equipped with suitable malleable iron or steel latches, stops, center rests and shall have satisfactory provisions for locking by means of padlocks. Gate hinges shall be malleable iron or pressed steel and shall be securely attached to the posts. Hinges shall not twist or turn under the action of the gate, and shall be so arranged that a closed gate cannot be lifted off its hinges. Vehicular gates shall be of the full 180-degree opening swing type and shall be so constructed and supported as to be easily operated by one person. All gates shall be equipped with a positive stop which will prevent the gate from being swung into a street or traffic lane; and all gates shall be furnished with a positive latch to hold the gate in a closed position.

9. All steel pipe, except for thin-wall, high strength pipe, used for top rails, line posts, corner, tension, terminal or gate posts, braces or gate frames shall conform to the requirements of ASTM A 120. Thin-wall, high strength pipe shall be manufactured by cold rolling using steel strip conforming to ASTM A 569.

GALVANIZING AND ALUMINUM COATING:

All materials used in "Chain Link Wire Fence" shall be galvanized, except that the fabric may be given an aluminum coating in lieu of galvanizing. Galvanizing shall be by the "hot dipping" process, and the zinc used shall conform to ASTM B6, and shall be of at least equal to the grade designated as "Prime Western". Fabric may be aluminum coating with a minimum weight of coating of 0.40 ounce per square foot [11grams per 0.1 squaare meters] in accordance with the ASTM A 428, or it may be coated with not less than 1.2 ounces [34 grams] of zinc coating in accordance with ASTM A 90. Fabric shall be hot-dip galvanized after weaving to conform to ASTM A 392, Class 1, or it may be aluminum coated in accordance with ASTM A 428.

Posts, braces and gates shall be hot-dip galvanized inside and out in conformance with ASTM A 120 or A 123. All fittings, bolts, and miscellaneous hardware shall be hot-dipped galvanized in conformance with ASTM A 90. All galvanized materials shall satisfy all requirements of the latest ASTM Standard Method of Test for Uniformity of Coating by the Preece Test (Copper Sulphate Dip) for Zinc-coated (Galvanized) iron and Steel Articles. The component parts of the fence will not be tested unless careful visual inspection indicated that the quality or workmanship does not comply with these specifications. If, in the opinion of the Inspector, testing is necessary, specimens for testing shall consist of one square foot [0.1 square meters] of woven fencing selected at any point in width of the fence fabric, exclusive of the twisted or knuckled portions, and shall be taken from the end of the roll. The zinc coating shall be tested by a stripping test in accordance with the latest ASTM Methods of "Test for Weight of Coating on Zinc-Coated (Galvanized) Iron and Steel Articles". Careful visual inspection shall be made to determine the quality of the zinc coating. Excessive roughness, blistering, sal-ammoniac spots, bruises, and flaking, if present to any considerable extent, shall provide a basis for rejection.

Thin-wall, high-strength pipe shall be externally hot-dip galvanized with the weight of the zinc coating determined in accordance with ASTM A 90. After galvanization, thin-wall, high-strength pipe shall also be externally chromated by total immersion followed by application of clear polyurethane finish. Internally, thin-wall, high-strength pipe shall have a zinc base coating with thickness of 0.5 mil plus or minus 0.2 mil. The coating shall be 81 percent zinc powder by weight.

SAMPLING:

The Contractor shall furnish, upon request of the Inspector, samples of each component part of the fence, including fittings. These samples shall be subjected to the galvanizing, weight and, where applicable, strength tests. A sample may be taken from each shipment and all samples shall be furnished the City without cost. If a sample or specimen fails to meet the requirements of this specification, two additional samples or specimens shall be taken from the same shipment and tested, both samples or specimens so tested shall meet the requirements in every respect, or the lot represented by the samples may be rejected.

CONSTRUCTION METHODS:

Chain Link Fence shall be erected at locations shown in the plans or as directed by the Inspector or in accordance with the details shown on the plans. The fence shall be true to line, taut and firmly fastened and shall comply with the best practice for fence construction of this type.

Posts shall be set in concrete to the depths indicated in the plans, plumb and permanently positioned and all anchorages firmly set before fabric is placed. Posts shall be set in Class "B" Concrete unless otherwise shown in the plans and concrete and equipment shall be in conformity to the requirements of Item No. 300, "Concrete (Class B)".

Concrete footings shall be not less than the size and depth shown in the plans. Concrete shall be placed and tamped into position with care to prevent entrance of soil from the walls of the hole. Earth coming in contact with concrete shall be moistened as directed by the inspector prior to placing concrete.

Tension posts shall be placed in long, straight runs of fencing and shall be spaced not more than 330 feet [100 m] apart or no straight run of fencing may be more than 330 feet [100 m] without a tension post. Corner posts shall be placed at each angle point and gate posts as shown shall be placed for each opening.
After all posts in a run of fencing have been permanently positioned and anchorages are firmly set, the fabric shall be placed by securing one end and applying sufficient tension to the other to remove all slack before making attachments. Fabric shall be fastened as shown in the plans or as called for herein, and the bottom of the fabric shall be placed a normal distance of 2-inches [50 mm] above the ground line; however, over irregular ground this distance may vary between 1-inch [25 mm] and 6-inches [152 mm] for a distance not to exceed 8-feet [2.4 m]. Any necessary backfilling required to comply with these conditions will be considered as incidental work.

MEASUREMENT:

"Chain Link Wire Fence", of the height specified, will be measured by the linear foot [meter] of fence at the bottom of the fabric along the center line of the fence from center to center of end posts, exclusive of gates. "Chain Link Wire Fence" shall include all end posts, angle and corner posts, and tension posts, complete in place with all bracing and accessories.

Gates will be measured per each gate of each type, complete in place with gate posts, all bracing and all accessories.

PAYMENT:

"Chain Link Wire Fence" measured as prescribed above, will be paid for at the contract unit price bid per linear foot [meter] for "Chain Link Wire Fence" of the height specified, which price shall be full compensation for furnishing and installing all fencing materials, end posts, angle and corner posts, tension posts, line posts, caps, tension wires, top rail, and connection fittings; digging post holes or setting into retaining wall and structures; furnishing and placing concrete for setting posts; all hauling and hauling charges; and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

Gates measured as prescribed above will be paid for at the contract unit price bid for each "Gate, Pedestrian" or "Gate, Vehicular" of each size called for, which price shall be full compensation for furnishing all materials; fabrication, preparation, hauling, handling charges, and erecting; including gate and gate posts, posts caps, braces, miscellaneous fitting and fastenings, latches, hinges, stops and holding devices; and for all manipulation, labor, tools, concrete for setting posts, equipment and incidentals necessary complete installation.

BID ITEM:

Item 507.1 - Chain Link Wire Fence - (4 ft. high) [1.2 m] - per linear foot [meter]

Item 507.2 - Chain Link Wire Fence -(6 ft. high) [1.8 m] - per linear foot [meter]

Item 507.3 - Chain Link Wire Fence - (8 ft. high) [2.4 m] - per linear foot [meter]

Item 507.4 - Gates - Pedestrian each.

Item 507.5 - Gates - Vehicular per opening.

ITEM 508
RELOCATING WIRE FENCE

This item shall govern for the removing and relocating the chain link, barbed wire or a combination of woven fence fabric and barbed wire fence(s), maximum six feet (1.83m) high, at the locations designated on the plans, and for furnishing and installing any additional materials required as specified by this item or as indicated on the plans.

MATERIALS:
All materials furnished shall be equal to or better than the materials of the existing fence unless specifically designated otherwise on the plans.

CONSTRUCTION METHODS:
1. Chain Link Fence: All construction methods shall conform to the provisions of Item 507, "Chain Link Wire Fence".

2. Barbed Wire or Woven Fence Fabric: Fence posts shall be spaced at 12 foot [3.6 m] intervals and set in a vertical position to a depth of 2-1/2 feet - 3 feet [0.7 m to 1 m]. Corner and pull posts shall be braced in two directions. End and gate posts shall be braced in one direction. Where alignment changes 30 degrees or more, a corner post shall be installed. At alignment angles varying between 15 and 30 degrees, the angle post shall be braced to adjacent line posts by diagonal tension wires. Where steel posts are used, a pull post assembly shall be installed at approximately 50-foot [15 m] intervals and where wood posts are specified the spacing of pull post assemblies shall be approximately 1000 feet [305 m], unless otherwise shown on the plans. Metal line posts may be driven in place providing such driving does not damage the posts. Metal corner, end, pull posts and braces shall be set in portland cement concrete footings crowned at the top to shed water. All posts shall be placed the minimum depth below ground as shown on the plans or as directed by the Inspector. Posts shall be set plumb and firm to the line and grade shown on the plans. Backfilling shall be thoroughly tamped in 4-inch [102 mm] layers.

The corner, end or angle post assembly shall be installed before stretching the wire between line posts.

At all grade depressions where stresses tend to pull the posts out of the ground, the fencing shall be snubbed or guyed at the critical point by means of a double 9 gauge galvanized wire connected to each horizontal line of barbed wire or to the top and bottom wire or wire mesh fabric, and to a deadman weighing not less than 100 pounds [[45 kg], buried in the ground as shown on plans. The fencing shall be stretched before being snubbed and guyed. Existing cross-fences shall be connected to the new fences and corner posts with braces which shall be placed at junctions with existing fences. The barbed wire and wire fabric shall be drawn taut and fastened to posts with galvanized ties or staples.

MEASUREMENT:
Accepted work as performed and prescribed by this item will be measured by the linear foot [meter] of fence relocated.

Gates will not be measured as a separate pay item, but will be included in the linear foot [meter] quantity.

PAYMENT:
The work performed and the materials furnished as prescribed by this item will be paid for at the contract unit bid price per linear foot [meter] for "Relocating Wire Fence", which price shall be full compensation for removing and reinstalling the existing fence and gates, and for furnishing all additional materials, for all labor, tools, equipment and incidentals necessary to complete the work.

BID ITEM
Item 508: Relocating Wire Fence - per linear foot [meter].

ITEM 509
METAL BEAM GUARD RAIL

This item shall govern for the installation of one line of metal beam rail element supported on timber posts. Metal beam guard rail shall be constructed of materials and workmanship as prescribed by these specifications, at such places as shown on the plans or as designated by the Engineer, and in conformity with the plans and typical details shown.

MATERIALS:

1. Rail Elements: The rail elements shall be of the deep beam type fabricated to develop continuous beam strength and shall consist of metal plate or sheet formed into a beam not less than 12 inches [305 mm] wide and 3 inches [76 mm] deep as shown in the plans. The beam shall be free from warp. When tested with a straight edge or string along either edge of a 12-1/2-foot [3.8 m] sectional length of beam, the maximum deviation of the beam edges from the straight edge shall not exceed 1/2 inch [13 mm] at any point.

The steel for the rail elements shall conform to the requirements of AASHTO M-180. The rail shall be of a 10 gauge nominal thickness (0.1345 $\pm$ 0.008 inch) [3.43 mm $\pm$ 0.20 mm] or 12 gauge nominal thickness (0.1046 $\pm$ 0.008) [2.67 mm $\pm$ 0.20 mm] as shown on plans. The rail element shall be galvanized before fabrication. Galvanizing shall be in accordance with the requirements of ASTM A 525.

Where painting and/or striping is expressly required on the plans, the rail elements need not be galvanized, but shall be painted in accordance with Item No. 514, "Paint and Painting".

2. Posts: The posts shall be timber and shall be of Southern Yellow Pine. All posts shall be round. End posts shall not be less, in any place, than 8-inches [203 mm] in diameter. Intermediate posts shall not be less, in any place, than 7-inches [178 mm] in diameter. They shall be the length shown on the plans. The bottom shall be sawed off square, and the top may be dome shaped or beveled with 10-15 degree bevel. All posts shall be peeled and trimmed of all knots and knobs and shall be straight and smooth. The posts shall be sound and free from defects such as injurious ring shakes, unsound or loose knots, or other defects which might impair their strength and durability. Sound knots will be permitted provided they are not in clusters and they do not exceed one-third (1/3) of the small diameter or least dimension of the post. Any defect or combination of defects which would be more injurious than the maximum allowable knot will not be permitted. A line drawn from the center of each end of the post shall not fall outside the center of the post at any point more than 1-1/4 inches [32 mm].

All timber posts shall be preservative-treated in accordance with Item 492, "Timber Preservative and Treatment", of the Texas Department of Transportation Standard Specifications.

3. Fittings: Fittings shall consist of bolts, nuts and washers and shall conform to the details as shown on the plans and shall comply with the requirements as specified herein.

All bolts and nuts used with painted steel rail shall be made by either the open-hearth or electric-furnace process and shall have proper strength for the purpose intended. They shall be hot-dip galvanized to conform to ASTM A 153.

The post connection shall withstand a 5,000 pound pull [22 240 newton] in either direction. Fittings shall conform to ASTM A-307.

CONSTRUCTION METHODS:

The posts shall be set plumb, firm, and to the line and grade shown on the plans. Unless the plans call for setting in concrete, the posts shall be backfilled by thoroughly tamping approved material in 4 inch [102 mm] layers. The rail elements shall be erected to produce a smooth, continuous rail paralleling the line and grade of the roadway surface or as shown on the plans. The rail elements shall be joined end to end by bolts and lapped in the direction of traffic in the lane adjoining the guard rail. When designated on the plans, the rail elements shall be curved before erection. Holes for special details may be field-drilled or punched, when approved by the Engineer.

Where damage has occurred during handling and erection, galvanized material shall be repaired by the application of "Galvaloy, AMCO No. 321, or ZRC" in accordance with the manufacturer's recommendations.

Where painting is specified, after erection all parts of painted steel rail elements on which the primer coat has been scratched or chipped shall be thoroughly cleaned

and spot painted with the paint specified for the first field coat. The spot coat shall be allowed to dry for at least 12 hours, after which the beam and posts shall be painted with the first field coat. After the first field coat has dried for at least 48 hours, the second field coat shall be applied.

MEASUREMENT:

Accepted work as prescribed by this item will be measured by the linear foot of rail, complete in place. Measurement shall be made upon the face of rail, from center to center of end posts or terminal anchor.

PAYMENT:

The work performed as prescribed by this item will be paid for at the contract unit price bid per linear foot [meter], measured as prescribed above, for "Metal Beam Guard Rail", which price shall include the terminal anchor section and be full compensation for furnishing all materials, for all preparation, hauling and erection and painting of same, for setting posts in concrete when specified, and for all labor, tools, equipment and incidentals necessary to complete the work, including excavation, backfilling and disposal of surplus material.

BID ITEM

Item 509: Metal Beam Guard Rail - per linear foot [meter]

ITEM 510
TIMBER GUARD POSTS

This item shall govern for installation of posts only and shall be constructed of materials and workmanship as prescribed by these specifications, at such places as shown on the plans or as designated by the Engineer, and in conformity with the designated plan and typical details shown.

MATERIALS:

"Timber Guard Posts" shall consist of posts only. All posts shall be of Southern Yellow Pine, sound and be preservative-treated in accordance with Item No. 492,"Timber Preservative and Treatment" of TXDOT Standard Specifications. Posts shall not be less than 6-inches [152 mm] in diameter at any point and shall be a minimum of 6 feet [2 m] long. The bottom shall be sawed off square and the top shall be dome shaped. The posts shall be sound and free from defects such as injurious ring shakes, unsound or loose knots, or other defects which might impair their strength and durability. All posts shall have two (2) strips of reflective sheeting as specified and shown on the plans.

All paint and painting if required shall conform to the requirements specified in Item No. 514, "Paint and Painting".

CONSTRUCTION METHODS:

Posts shall be set in holes with 3-feet [1 m] exposed above ground, as shown in the plans. The posts shall be set plumb and firm to the line and grade, shown on the plans. Backfilling shall be thoroughly tamped in 4 - inch [102 mm] layers.

MEASUREMENT:

"Timber Guard Posts" will be measured as each post, complete in place.

PAYMENT:

The work performed and material as prescribed by this item, measured as provided under "Measurement" will be paid for at the contract unit price bid for "Timber Guard Posts", which price shall be full compensation for furnishing all materials, for all preparation, hauling and installation of same, and for all labor, tools, equipment and incidentals necessary to complete the work, including furnishing and applying all paint, excavation, backfilling and disposal of surplus material.

BID ITEM

Item 510: Timber Guard Posts - per each.

ITEM 511
CUTTING AND REPLACING PAVEMENTS (TRENCH REPAIR)

This item shall govern for the cutting of pavements, the removal of base and the replacement of base material and pavements on cuts up to six (6) feet [1.8 meter] in width, as herein specified and in conformity with the typical sections shown on the plans and to the lines established by the Engineer.

MATERIALS:

1. Concrete: All concrete shall conform to the provisions Item 300, "Concrete" (Class A).

2. Reinforcing Steel: All reinforcing steel shall conform to the provisions of Item 301, "Reinforcing Steel".

3. Membrane Curing: All membrane curing shall conform to the provisions of Item 305, "Membrane Curing".

4. Tack Coat: All tack coat shall conform to the provisions of Item 203, "Tack Coat".

5. Hot Mix Asphaltic Concrete Pavement: All hot mix asphaltic concrete pavement shall conform to the Provisions of Item 205, "Hot Mix Asphaltic Concrete Pavement".

6. Asphalt Treated Base: All asphalt treated base shall conform to the provisions of Item 206, "Asphalt Treated Base".

CONSTRUCTION METHODS:

1. Cutting of Pavements:

a. Concrete and Asphaltic Concrete Pavements: shall be cut with a concrete saw. The depth of the cut shall be such that upon removal of concrete and/or asphaltic concrete the sides of the cut will be straight and square. Care shall be taken, when cutting concrete pavement, not to cut transverse reinforcing steel.

b. Asphalt Surface Treatments: shall be cut by means of sharp axes or hand held pneumatic tools with wedge bits, or other approved equipment.

2. Removal of Bases:

a. Concrete and Cement Stabilized Bases: shall be removed by means of hand held pneumatic pavement breakers with approved cutting bits. It is the intent of this specification that the base shall be removed in a manner that will leave the sides of the cut straight and square.

Where reinforcement is encountered in concrete bases, a minimum of 1 foot [305 mm] shall be cleaned of all old concrete and left in place to tie to new reinforcement in the new concrete base.

b. Flexible Bases: shall be removed by normal trenching operations.

3. Replacement of Bases:

a. Concrete Bases: shall be replaced with Class "A" concrete conforming to the provisions of Item 300, "Concrete". If existing concrete is steel reinforced, the reinforcing steel shall be replaced in accordance with Item No. 301, "Reinforcing Steel". The concrete shall have a slump of not more than 3 inches [76 mm] and shall be spaded, tamped and finished to the satisfaction of the Inspector. Immediately following finishing operations, the surface shall be cured in accordance with the provisions of Item 305, "Membrane Curing". The concrete shall be protected from traffic for seventy-two (72) hours.

b. Cement Stabilized Bases or Flex Base: shall be replaced with asphalt treated base in accordance with Item 206, "Asphalt Treated Base" or with Controlled Low Strength Material conforming to the requirements of Item 400 "Excavation, Trenching & Backfill". It is perferd that Asphalt Treated Base be "Hot - Mix, Hot - Laid".

4. Replacement of Pavements: Pavements shall be replaced under this item with hot-mix asphaltic concrete pavement, in the thickness and type shown on the plans.

Hot mix asphaltic concrete shall be furnished and placed in accordance with Item 205, "Hot Mix Asphaltic Concrete Pavement." All concrete bases shall receive a tack coat of asphalt or emulsion in accordance with the provisions of Item 203, "Tack

Coat" prior to replacement of hot mix asphaltic concrete.

When the replacement pavement is Portland Cement concrete as indicated on the plans, "Class A" Concrete shall be furnished and placed in accordance with Item 300, "Concrete", and in accordance with Construction Methods, "Concrete Bases" above. The concrete shall be placed, spaded, tamped and finished to the line, grade and texture of the surrounding concrete pavement.

Where the existing pavement is single or double surface on the plans, replacement surface pavement will not be required under this item. Such surface treatments will be constructed to the widths and details shown on the plans and measured and paid under Item 204, "Surface Treatments".

MEASUREMENT:

Cutting and replacing pavements will be measured by the square yard [square meter] of pavement so cut and replaced, of the type and depth indicated in the plans and bid proposal and of the limits shown in the plans. Materials used in replacing bases and pavements such as flexible base, cement stabilized base, concrete, reinforcing steel, prime coat, tack coat and asphaltic concrete pavement will not be measured directly for payment. Depth will be measured from the top of pavement to the bottom of new base material.

PAYMENT:

Payment for cutting and replacing pavements will be made at the contract unit price bid persquare yard [square meter] for "Cutting and Replacing Pavements" of the type and depth classification shown on the plans. Where the depth of replaced base and pavement differs from that shown on the plans and bid proposal, the contract unit price bid per square yard [square meter] shall be adjusted by the ratio of the actual depth of pavement and base replaced to the depth shown on the plans and in the bid proposal. Such variations in depth shall be subject to approval of the Inspector in writing.

The contract unit price bid for "Cutting and Replacing Pavements" shall be considered as full compensation for cutting pavements, removing bases, replacing bases and pavements, removing and disposing of all surplus materials, furnishing and placing all new materials, and for all manipulations, work, tools, equipment, labor and incidentals necessary to complete the work.

BID ITEM

Item 511.1: Replacing with Flexible Base and Pavement - inches [mm] compacted depth -per square yard [square meter].

Item 511.2: Replacing with Concrete Base and Pavement inches [mm] depth - per square yard [square meter].

Item 511.3: Replacing with Asphalt- Treated Base and Pavement inches [mm] compacted depth - per square yard [square meter].

Item 511.4: Replacing with Reinforced Concrete Pavement - inches [mm] depth - per square yard [square meter].

ITEM 512
ADJUSTING EXISTING MANHOLES

This item shall govern for of the adjustment of all storm drainage, sanitary sewer, and other manholes belonging to the City of San Antonio, regardless of type shown on the plans, and in conformity with the provisions of these specifications.

The above referenced manholes shall not include those owned by the City Public Service Board, Southwestern Bell Telephone Company, Western Union or any other privately owned utility.

CONSTRUCTION METHODS:

Manholes shall be lowered below subgrade before placing base materials and openings shall be protected by hatch covers.

Existing manhole rings and covers which are determined by the Inspector to be in an unacceptable condition, will be removed and replaced with new rings and covers.

Manholes shall be adjusted after the base material has been laid and before placing of the surface course. All manholes shall then be raised, or lowered a sufficient height so as to be level with the finished surface course.

Adjusting Existing Manholes: Adjustment in height will be made by addition or removal of "throat rings" above the manhole "cone" where feasible. Maximum number of throat rings allowed is six (6).

Reconstructing Existing Manholes: Major adjustments will be made by reconstruction of the manhole below the "cone" where necessary. Material excavation from around the manholes shall be replaced with concrete meeting the requirements of Item No. 300, "Concrete (Class B)", and select materials from the excavation (as shown on the plans or specified by the City). All excess materials shall be disposed of by the Contractor.

MEASUREMENT:

Manholes completely adjusted or reconstructed, as prescribed above, will be measured by the unit of each manhole adjusted or reconstructed. Manhole rings and covers which have been removed and replaced shall be measured by the units of each manhole ring and cover which has been removed and replaced. The excavation and the amount of concrete necessary to fill the area excavated will not be measured for payment.

PAYMENT:

The work performed as prescribed by this item will be paid for at the contract unit price bid per manhole for "Adjusting Existing Manholes", "Reconstructing Existing Manholes" or "Replacing Rings & Covers", which price shall be full compensation for all excavation and disposal of material excavated; for furnishing and placing all materials, and for all labor, tools, equipment and incidentals necessary to complete the work.

BID ITEM

Item 512.1: Adjusting Existing Manholes - per each.
Item 512.2: Reconstructing Existing Manholes - per each.
Item 512.3: Replacing Rings and covers - per each.

ITEM 513
REMOVING AND RELOCATING MAIL BOXES

This item shall govern for the removal, temporarily relocating and replacing mail boxes as shown on the plans or as directed by the Inspector.

CONSTRUCTION METHODS: The mail boxes and any supporting posts shall be removed from their present location, installed in a temporary, serviceable location or locations during construction and replaced in a permanent location as shown on the plans. Any supporting posts found to be set in concrete at the time of their removal shall be reset in the permanent location in concrete. As a minimum, each individual mailbox shall be set on a 4" x 4" [102 x 102 mm] wood post, equal or better than the original, at the location and to the height shown on the plans.

Temporary community boxes may be required in lieu of temporarily relocating existing mail boxes. Community boxes will be installed by the U.S. Postal Service on concrete slabs installed as a part of this contract. Contractor shall install temporary concrete pads at locations and dimensions as shown on the plans, or as directed by the Inspector. Contractor shall remove concrete slabs upon completion of the project.

Mail boxes found to be set on ornamental iron, masonry or other special posts shall be relocated on such posts undamaged by the Contractor.
Any damage to the mail boxes, posts, supporting members, braces etc., caused by negligence of the Contractor shall be remedied by the Contractor at his expense. All such repairs shall be made in such a manner so as to insure the unit to be in as good as, or better condition than it was originally. Any such repairs shall be subject to approval by the Inspector.

MEASUREMENT:

"Removing and Relocating Mail Boxes" will be measured by the number of mail boxes so removed and relocated. Concrete slabs for community mail boxes will be measured by the square yard (square meter), complete and in place, to include removal at job completion.

PAYMENT:

The work performed as prescribed by this item will be paid for at the contract unit price bid, per mail box, for "Removing and Relocating Mail Boxes" which price shall be full compensation for removing mail boxes from their present position, temporary relocation in a serviceable position, and relocation to permanent designated location, for resetting in concrete if required, for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work.

Temporary Community Mail Boxes. Work performed as prescribed by this item will be paid for at the contract unit price bid per square yard [square meter], which price shall be full compensation for the construction and removal of concrete slab(s), materials including reinforcing, labor, tools, equipment and incidentals necessary to complete the work.

BID ITEM

Item 513.1: Removing and Relocating Mail Boxes - per each.
Item 513.2: Community Mail Box Slab - per square yard [square meter].

ITEM 514
PAINT AND PAINTING

This item shall govern for type, quality, and testing of paints, their source, and for the application of paint to structures and appurtenances. The painting of structures and appurtenances shall include, unless otherwise provided in these specifications, or the contract, the preparation of the surfaces, the application, protection and drying of the paint coatings, the protection of all traffic upon, underneath, or near the structure, the protection of all parts of the structure against disfigurement by any and all of the painting operations.

MATERIALS:

Paints furnished under these specifications shall be as follows:

1. Bridge structural shapes:

a. Shop Coat: "Rust-Oleum" No. 678 Quick-Drying Red Primer as manufactured by the Rust-Oleum Corporation, or equal approved by the Engineer.

b. First Field Coat: "Rust-Oleum" No. 7773 Zinc Chromate Primer as manufactured by the Rust-Oleum Corporation or equal approved by the Engineer.

c. Second Field Coat: "Rust-Oleum" No. 7233 "Restful Green" semigloss as manufactured by the Rust-Oleum Corporation, or equal approved by the Engineer.

If the Contractor elects to provide paints other than these specified above, it shall be his responsibility to furnish proof that the paint supplied is in all respects equal to that specified. In addition, he may be required to furnish manufacturer's literature with regard to colors, application recommendations and requirements for thinners. The Engineer may require that paint samples be tested by an independent laboratory approved by the City and at no cost to the City, to insure that the paint supplied is equal to that specified.

CONSTRUCTION METHODS:

CLEANING AND PREPARATION OF SURFACE:

1. Regular Cleaning: Throughout paint application, including shop and field painting, no paint shall be applied over a surface which evidences a loose, scaly, or flaking condition. The most effective and practical methods shall be employed to remove all loose mill scale, rust, dirt and all other foreign substances which would be deleterious to the procurement of a firm paint coating. The original cleaning and preparation of the surface must be done at the fabricating plant before application of the shop coat, but the same general requirements for painting over a clean, firm surface shall be applicable to all coats.

Any effective methods for removal of rust and scale, such as the use of sand blast, hand or rotating metal brushes, scrapers, chisels, hammers, flame-cleaning, or other effective means will be acceptable. Undesirable contaminants such as grease, oil, dirt, and moisture must be removed prior to paint application. Condensed moisture shall be avoided as directed as per "Weather Conditions and Dry Mass of Surface". Grease-like contaminants shall be removed with clean petroleum solvents in such manner that the oil substance is actually removed and not simply diluted or spread out over a greater area.

All welds shall be flushed thoroughly with clean water before painting so as to remove any alkaline residue; the flushed surfaces then shall be allowed to become thoroughly dry before paint application. Paint will not be applied to welds prior to three (3) days after welding. Particular attention shall be given to the cleaning of fillets, riveted areas, rivet heads, bolt heads, nuts, washers, drilled or punched holes, and welds, where loose mill scale, rust, oil and flux are likely to be present.

Where cleaning is required, paint shall not be applied closer than 6 inches [152 mm] to a surface which has not been cleaned.

2. Sand Blast Cleaning: In addition to the requirements above, the following additional requirements shall govern when sand blast-cleaning is required, or used, at the option of the Contractor, with spray application of paint:

a. All deposits of oil, grease, and similar deleterious matter shall be removed by solvent cleaning prior to sand blasting.

b. All mill scale shall be removed. Uniformity of color or contour is not required.

c. The maximum height of profile of the anchor pattern shall not exceed 2.5 mils.

d. Sand blast-cleaned surfaces shall be covered completely with the initial coat of paint within eight (8) hours after cleaning, or shall be re-cleaned by sand blasting immediately prior to painting.

WEATHER CONDITIONS AND DRYNESS OF SURFACE:
Paint shall not be applied to any surface containing moisture discernible to the eye or by the following test for condensation. If temperature and humidity conditions are such that moisture is condensing upon the surface, a small area on the surface shall be moistened with a damp cloth so as to apply a clearly defined, thin film of water; if this thin film evaporates after fifteen (15) minutes, the surface shall be considered safe to paint from the standpoint of continued condensation at that particular time. Paint shall not be applied at air temperature below 40° F [4 °C]., nor when there is likelihood of a change in weather conditions within two (2) hours after application, which would result in air temperatures below 40° F [4 °C], or deposition of moisture in the form of rain, snow, condensation, etc., upon the surface. The Inspector shall have the authority to order that the paint shall not be applied when impending weather conditions might result in injury to fresh paint.

CARE OF PAINTS:
Paints being applied shall be mixed thoroughly and strained. They shall be completely homogenous mixtures free of lumps, skins, or agglomerates, and shall contain all pigments, vehicle solids, and thinners required in the original formulation. Paint containers shall be kept tightly covered when not in use.

BRUSH APPLICATION:
It shall be mandatory to apply the shop coat by brush or roller, except that spray application will be permitted on sand blasted surfaces. Painting shall be done by workmen skilled in the craft of structural metal painting. Brushes, preferably, shall be round or oval in shape, but if flat brushes are used, they shall not exceed 4 inches [102 mm] in width; brushes should be springy and not flabby. Brushes shall be kept free of all contaminants.

SPRAY APPLICATION:
All coats may be applied by roller, spray, brush or a combination thereof, subject to the provisions of paragraphs "Brush Application and "Shop Coat".

The equipment used for spray painting shall meet with the approval of the Inspector and shall have adequate provision by separation of moisture from any air stream in contact with the paint. All spray guns shall be adequate for the type of paint being used and shall be equipped with suitable spray heads as necessary to obtain the application of an even, smooth coat of paint.

SHOP COAT:
When all fabrication work is completed all surfaces not painted before assembling shall be cleaned as previously stated and painted with the required shop coat. Pieces shall not be loaded for shipment until thoroughly dry. No painting shall be done after loading material on cars. Erection marks for the field identification of members shall be painted upon previously painted surfaces. Surfaces to be in contact after shop riveting shall be cleaned but not painted.

The shop coat of paint shall be omitted from the surfaces of steel members which will be in contact with the slab concrete in the finished structure. At the time concrete is placed, such surfaces of structural steel shall be free from dirt, scale, rust, paint, oil, or other foreign material.

Machine finished surfaces which are to be in sliding contact in the structure shall be coated with a hot mixture of white lead and tallow before being removed from the shop. This refers to particularly to pins and holes for pins. The composition used for coating these machined finished surfaces shall be mixed in the following proportions:

4 lbs. pure tallow [1.8 kg]
2 lbs. pure white lead [0.9 kg]
1 quart pure raw linseed oil [0.9L]

All metal surfaces which will be within 2 inches [50 mm] of field welds shall be coated with linseed oil in advance of the application of shop coat paint and left bare of paint until field welding is completed. All surfaces other than those above mentioned shall receive a shop coat of paint regardless of whether or not the surface in question will be in direct contact with concrete or other masonry in the finished structure. Unless otherwise shown an the plans, the surfaces to be shop-painted will include the rolling faces of rockers and base plates, all surfaces of bearing plates, and all surfaces of iron or steel castings regardless of whether or not such surfaces are milled, except those surfaces in sliding contact as described above.

On non-sandblasted surfaces the shop coat shall be applied as uniformly as possible by brush or roller to provide a minimum dry film thickness of 1.8 mils.

Shop coats applied to sandblasted surface shall provide a minimum dry film thickness of 2.2 mils, and shall cover all peaks of the anchor pattern.

Spray application of shop coat will be permitted only when the surfaces are cleaned by sandblasting.

The shop coat should be allowed to dry for a period of forty-eight (48) hours before handling or further painting.

Deterioration of the paint film or painted surfaces shall be cared for, prior to shipment, by such methods as are necessary to restore the surface to its original condition of cleanliness and paint quality. A light application of shop coat paint may be required if conditions warrant.

FIELD CLEANING AND SPOT PAINTING:
When the erection or maintenance work is complete, including all riveting, straightening of bent metal, etc., the previously painted face shall be restored to a serviceable condition acceptable to the Inspector by means of preparation of surface as outlined in Construction Methods and by smoothing and touching up marred places in the previously applied paint film with shop coat unless otherwise specified. Heads of field rivets and bolts, field welds and surrounding unpainted areas, and any other surfaces to repainted which have not been painted shall be painted with shop coat unless otherwise specified. The coating of white lead and tallow specified above shall be removed completely as directed for removal of grease and oil.

FIRST FIELD COAT:
When field cleaning and restoration of shop coat has been completed and the shop coat is thoroughly dry, the first field coat of paint may be applied. Finished surfaces intended for sliding contact shall be given a coat of approved graphite grease immediately prior to being placed in the structure. Graphite greases shall be composed of dry graphite flakes mixed with sufficient light grease or heavy oil so as to form a thick paste suitable for the purpose. Field coats will not be required on the bottom surfaces of shoe castings or bearing plates in direct contact with concrete nor on the top surfaces of beams, girders, etc., on which a concrete slab is to be placed in direct contact.

The first field coat shall be applied as uniformly as possible by spray, brush, or roller to provide a minimum dry film thickness of 1.8 mils.

SECOND FIELD COAT:
The previous paint coat shall be restored as necessary. After the necessary spot painting has dried completely, the surfaces shall be cleaned and the second field coat applied by spraying. The rate of application shall be such as to obtain an adequate and uniform coverage of metal and shall be not less than 1.0 mil film thickness when dry. Application shall be in accordance with Applicable Application paragraph above.

THINNING:
Paint may be adjusted to the correct application consistency by the addition of proper thinners. Only thinners of the proper type, And in the proper amounts as recommended by the manufacturer of the paints will be permitted.

REMOVAL OF PAINT IMPROPERLY APPLIED:
All applied paint which has been applied improperly, or fails to dry and harden properly, or to adhere tightly to underlying metal or other paint film, or does not evidence a normal, workmanlike appearance in conformance with the intent of these specifications, shall be remedied or completely removed and replaced at the expense of the Contractor. When the final field coat does not have a uniform color and appearance throughout the structure, it shall be corrected by the use of whatever additional coats are necessary. Removal of freshly applied paint which has not yet set shall be removd with the use of suitable solvents.. Removal of dried paint films shall be effected either by means of sand blast, scraping, or flame torches meeting the approval of the Inspector.

INTENT: The intent of this specification is to procure the specified paints in place on structures and/or railings, so that the durability and protective value of these paints will be realized in service. Accordingly, the best quality materials and workmanship are implied throughout.

Surface conditions and application requirements are specified with the intent to obtain full adhesion of paint to clean, dry, firm surfaces on the bare metal and between coats. This will require careful attention to preparation of surface, to prevention contamination and marring of coating during and after drying, and to uniform, skilled application.

Portions of structures entailing difficult application of the field coats after erection, may be completely painted before assembling or erection at the discretion of the Inspector.

MEASUREMENT:
"Paint and Painting" will not be measured for payment.

PAYMENT:
The work and materials prescribed herein will not be paid for directly, but shall be included in the unit bid price for the items of construction in which this work and materials are used.

ITEM 515
TOPSOIL

This item shall govern for the furnishing, placing and spreading of approved selected topsoil, to the lines and grades, at locations shown on the plans or as directed by the Inspector and in conformity with these specifications.

MATERIALS:

The topsoil shall be obtained from approved sources, suitable to support plant growth (seeding or sodding). It shall be fertile loam, easily cultivated, and free from roots, weeds, stones or other objectionable material detrimental to plants.

CONSTRUCTION METHODS:

Topsoil shall be placed and spread on the places designated on the plans, or on areas as directed by the Inspector. The minimum thickness of topsoil shall be 4 inches [102 mm] on excavated areas. Where no excavation was accomplished, the topsoil shall be placed and spread and brought to the proper line and grades as shown on the plans. After the topsoil has been placed and shaped, it shall be sprinkled with water. If the topsoil settles below the kestablished grade after the application of water, additional topsoil shall be added and sprinkled with water as directed by the Inspector.

MEASUREMENT:

Measurement of "Topsoil" shall be made by the cubic yard [cubic meter] in place and only for those areas designated on the plans, or to areas as directed by the Inspector.

PAYMENT:

Topsoil measured as specified above will be paid for at the contract unit price bid per cubic yard [cubic meter], which price shall be full compensation for all hauling, placing material, sprinkling the material with water, and for all labor, equipment, tools and incidentals necessary to complete the work.

BID ITEM

Item 515: Topsoil - per cubic yard [cubic meter].

ITEM 516
SODDING

This item shall govern for the furnishing and planting of Bermuda, St. Augustine, Buffalo 609 or other acceptable grass sod on the areas designated on the plans or as directed by the Engineer. All planting shall be completed as soon as practical to avoid erosion of topsoil and graded areas in advance of acceptance of the work.

MATERIALS: The sod shall consist of live, growing grass secured from sources where the soil is fertile. All grass sod shall have a healthy, virile root system of dense, thickly matted roots throughout the soil of the sod for a minimum thickness of 1 inch[(25 mm]. The Contractor shall not use sod from areas where the grass is thinned out, nor where the grass roots have been dried out by exposure to air and sun to such an extent as to damage its ability to grow when transplanted. The sod shall be free from obnoxious weeds or other grasses and shall not contain any matter deleterious to its growth or which might affect its subsistence or hardiness when transplanted. Sources from which sod is to be obtained shall be subject to approval by the Engineer.

CONSTRUCTION METHODS:

1. General. After the designated areas have been completed to the lines, grades, and cross sections shown on the plans and as provided for in other items of this contract, sodding of the type specified on the plans or as designated by the Inspector, shall be performed in accordance with the requirements hereinafter described.

Where rolling is specified by the following subarticles, the roller shall be a light corrugated drum roller.

2. Watering. Sod shall be thoroughly watered immediately after planting and subsequently at such intervals to promote growth or as directed by the Inspector.

3. Fertilizing. A pelleted or granulated fertilizer shall be used with an analysis of 16-8-8. (The figures in the analysis represent the percent of nitrogen, phosphoric acid, and potash nutrients respectively.)

The fertilizer shall be applied uniformly over the sodded areas and in the manner directed. The fertilizer shall be dry and in good physical condition. Fertilizer that is powdered or caked will be rejected. Distribution of fertilizer for the particular item of work shall meet the approval of the Inspector. Unless otherwise indicated on the plans, fertilizer shall be applied uniformly at the average rate of 300 pounds per acre [0.03 kilograms per square meter) for all types of sod.

4. Planting Season. All planting shall be done between the average date of the last freeze in the spring and six weeks prior to the average date for the first freeze in the fall according to the U.S. Weather Bureau for the area.

5. Finishing: Where applicable, the shoulders, slopes, and ditches shall be smoothed after planting has been completed and shaped to conform to the cross-section previously provided and existing at the time sodding operations were begun. Any excess dirt from the planting operations shall be spread uniformly over adjacent areas or disposed of as directed by the Inspector so that the completed surfaces will present a sightly appearance.

6. Block Sodding. At locations shown on plans or where directed by the Inspector, sod blocks shall be carefully placed on the prepared areas. The fertilizer shall then be applied and thoroughly watered. When sufficiently dry, the sodded area shall be rolled or tamped to form a thoroughly compacted, solid mat. Any voids left in the block sodding shall be filled with additional sod and tamped.

7. Sequence of Sodding: It is the intent of this specification that all sodding be placed and watered twice a week, unless intervening rains make watering unnecessary. Watering shall be required for at least thirty (30) days after planting to establish growth or until acceptance of the work by the City. If the season is inappropriate, the Inspector may require that the sodding operations be advanced or retarded as may seem advisable. All areas shall be covered with live sod before final acceptance. Any blocks which show no signs of life shall be replaced with live sod before the work shall be measured for payment.

MEASUREMENT:

Measurement of acceptable "Sodding", complete in place, will be by the square yard [square meter]. Fertilizer and water will not be measured for payment.

PAYMENT:

"Sodding", measured as provided above, will be paid for at the contract unit price bid per square yard [square meter], which price shall be full compensation for furnishing, hauling and placing all materials, for all fertilizer and water required and for all labor, tools, equipment and incidentals necessary to complete the work.

BID ITEM

Item 516.1: Bermuda Sodding - per square yard [square meter].

Item 516.2 St. Augustine Sodding per square yard [square meter].

Item 516.2 Buffalo 609 Sodding per square yard [square meter].

ITEM 517
BRIDGE RAILING

This item shall govern for the furnishing and installation of railing for bridges and box culverts, complete on the structures and in conformity with the lines, dimensions and details shown an the plans and with the provisions of these specifications.

This item shall include all posts, connections, parts and accessories, all required anchorage in the structures, headwalls, wingwalls, and parapet walls for proper anchorage of the post. Concrete parapet walls, headwalls, etc., and the reinforcing steel thereof, (except rail anchorage) will not be considered as parts of the rail for payment, but shall be paid for at the contract unit price bid for their respective items.

GENERAL:

Steel railing may be either galvanized or painted in accordance with the details on the plans. Where galvanized railing is required, railing shall be hot-dip galvanized in accordance with ASTM A123 and A153. Where deep beam rail elements are specified on the plans, they may be galvanized before fabrication in accordance with ASTM A525. Damage to galvanized material shall be repaired by the application of "Galvaloy, AMCO No. 321, or ZRC" in accordance with the manufacturer's recommendations.

Where steel railing is provided and painting is required by the plans, railing and exposed anchorage shall be given three coats paint in accordance with Item 514, "Paint and Painting", except that both the first and second field coats of paint shall be "Aluminum" paint as described in the specification.

MEASUREMENT:

Railing of the classification and type designated will be measured by the linear foot [meter], end to end of rail, complete in place in accordance with the dimensions and details governing the quantities as shown in the plans.

PAYMENT:

Payment for railing will be made at the contract unit price bid per linear foot [meter] for "Bridge Railing" as shown on the plans, complete in place, measured as herein provided; which price shall be full compensation for furnishing and installing railing complete with all accessories and incidentals
necessary to complete the work in the manner and in accordance with the details on the plans.

BID ITEM

Item 517: Bridge Railing - per linear foot [meter].

ITEM 520
HYDROMULCHING

This item shall govern for preparing ground, providing for sowing of seeds, mulching with cellulose fiber and other management practices along and across such areas as are designated on the plans and in accordance with these specifications. All areas shall be covered with live grass before acceptance.

MATERIALS:

1. Seeds: All seed must meet the requirements of the Texas Seed Law including the labeling requirements for showing purity, germination, name and type of seed. Seed furnished shall be of the previous season's crop for the date of the project. Each variety of seed shall be furnished and delivered in separate bags or containers. A sample of each variety shall be furnished for analysis and testing when directed by the Engineer. The amount of seed planted per acre shall be of the type specified below and shall equal or exceed the following percentages for purity and germination or an equivalent amount of pure live seed.

Common Name: Bermuda and Giant
Bermuda grass (hulled)

Scientific Name: Cynodon Dactylon

Purity: 95%

Germination: 90%

Annual Rye grass will be free of Johnson grass, field bind weed, dodder seed, and free of other seed to the limits allowable under the Federal Seed Act and applicable State Seed Laws.

Annual Rye grass will be added into slurry between October 1 through March 15. No additional cost will be charged to the City.

2. Wood Cellulose Fiber Mulch: Wood cellulose fiber mulch shall be natural cellulose fiber mulch produced from grinding clean, whole wood chips, or fiber produced from ground newsprint with a labeled ash content not to exceed 7%. The mulch shall be designed for use in conventional mechanical planting, hydraulic planting of seed or hydraulic mulching of grass seed, either alone or with fertilizer and other additives. The mulch shall be such that when applied, the material shall form a strong, moisture-retaining mat without the need of an asphalt binder.

The mulch material will also be dyed with a green color to assist in determining coverage and to provide an immediate pleasing appearance. The wood cellulose fiber is also required to be dispersed rapidly in water to form a homogeneous slurry and remain in such state when agitated in the hydraulic mulching unit with the specified materials.

3. Fertilizers: Fertilizer shall have a chemical analysis of 15-15-15 with micronutrients and shall be water soluble. (The figures in the analysis represent the percent of nitrogen, phosphoric acid and potash nutrients respectively.) Fifty percent or greater of the Nitrogen required shall be in the form of Nitrate Nitrogen ($N0_3$). The remaining Nitrogen required may be in the form urea Nitrogen ($C0(NH_2)_2$).

In the event it is necessary to substitute a fertilizer of a different analysis, it shall be a pelleted or granulated fertilizer with a lower concentration, but the total amount of nutrients furnished and applied per acre shall equal or exceed that specified for each nutrient.

The fertilizer shall be dry and in good physical condition. Fertilizer that is powdered or caked will be rejected.

4. Tactifier and binder: Natural vegetable gum containing gelling and hardening agents that when mixed with water and properly cured, shall form an insoluble network.

5. Water. Shall be furnished by the contractor and shall be clean and free of substances harmful to the growth of vegetation.

6. Herbicide: Herbicide used shall be an easy to apply, effective in a short term, chemical agent to inhibit or destroy weed growth, while being harmless to seed and grass being implanted.

7. Topsoil: Topsoil shall conform to the provisions of Item 515 "Topsoil".

CONSTRUCTION METHOD:

1. Security of stored hydromulch materials will be the sole responsibility of the Contractor at no additional expense to the City.

It is the contractor's responsibility to verify the location of all utility lines, electric cables, sprinkling systems and conduits so that the proper precautions must be taken not to disturb or damage any subsurface

improvements. Should obstructions be found, the Contractor will promptly notify the City Inspector. Any damage caused by the contractor shall be repaired by himself at no cost to the City. Any such repairs shall be subject to approval by the Inspector.

2. Preparation of Subsoil: Inspect subsoil for the presence of objectionable materials, such as rocks (2 inches [50 mm] in diameter and larger), concrete waste, building debris, weeds, grass or other material that would be detrimental to the growth of grasses. Protect existing underground improvements from damage.

Cultivate to a depth of 3 inches [76 mm] in areas to receive hydromulch. If compaction is due to equipment, traffic or storage, cultivate to a depth of 6 inches, and apply herbicide as directed by manufacturer.

Remove any foreign or objectionable materials collected during cultivation.

Grade to eliminate rough spots and low areas where ponding may occur. Assure positive drainage away from all buildings. Maintain smooth, uniform grades.

Hydromuch area and weed control shall consist of killing all weeds and maintaining a weed-free condition until completion of the project by applying herbicide as directed by the manufacturer.

3. Seeded Lawns: The following construction sequences and procedures shall be observed:

A) The contractor shall notify the Inspector not less than 48 hours in advance of any seeding operation and shall not begin the work until areas prepared or designated for seeding have been approved.

B) Before placement of hydromulch, all areas shall be cultivated to a depth of 3 inches [76 mm] unless otherwise specified or ordered by the City Inspector. Cultivation of the soil may be done by disc, spring tooth harrow, rototiler, or similar equipment. This operation shall be done at right angles to the natural flow of water on the slopes.

C) The area shall then be rolled in two directions; the second shall be done at right angles to the first rolling.

D) Rake the area to make it smooth and level. Add soil where necessary or as directed by the Inspector.

E) The finished grade shall be 1 inch (25 mm) below all curbs, sidewalks, and/or other appurtenances.

F) Apply the fertilizer at the rate and mixture specified. The fertilizer shall be applied by an approved hand or mechanical method.

G) Roll the area in one direction.

H) Slurry to be sprayed evenly in two intersecting directions with a hydraulic seeder.

I) Erect a barrier of stakes and strings, and post warning signs where necessary, or as directed by the Inspector.

J) Apply water as required to keep the mulch damp at all times throughout germination and initial growth period as determined by the Inspector.

K) Upon completion, all excess material shall be removed and disposed of off the project site at contractor's expense.

4. Slurry: The slurry will be mixed and spread uniformly over the area at the following rate:

Residential area or commercial area:
Wood Cellulose Fiber Mulch –2000 lb./acre.
Fertilizer – 400 lb./acre.
Bermuda – 1.5 lb./1000 sq. ft.
Annual Ryegrass (Oct. through March 15) –
20 lbs. per 1000 sq. ft.

Water and binder to be added according to manufacturer's recommendations.

5. Guarantee and Lawn Established Period: The guarantee and lawn established period shall begin immediately after the completion of the planting and shall start with the Provisional Acceptance and end with the Final Acceptance.

A) Provisional Acceptance:
Upon completion of hydromulching and written request of Contractor, the Inspector will inspect all the work for Provisional acceptance.

B) Guarantee Period:
The guarantee period shall begin upon completion of the provisional acceptance. All plant materials shall be guaranteed by the Contractor for a period of thirty days (30) from the date of provisional acceptance, to be in good, healthy, and nourished condition. The exceptions are damages resulting from neglect by the property owner, abuse or damage by others, or unusual phenomena or incidents which are beyond the Contractor's control.

During the lawn establishment period, it shall be the contractor's responsibility to ensure the continuing healthy growth. This care shall include labor, water and material necessary to keep the project in a presentable condition, including but not limit to removal of litter, mowing, trimming, removal of grass clippings, edging, fertilization, insecticide and fungicide applications, weed control, and repair and reseeding any and all damaged areas.

Water application shall be accomplished each week from March through October. An even application of one inch minimum of water shall be required over all lawn areas weekly. The rate and frequency of water application may be changed, as directed by the Inspector, depending on weather, and soil conditions.

C) Replacement:
The Contractor shall replace, without cost to the City, and as soon as weather conditions permit, all dead grassed areas not in a vigorous, thriving condition, as determined by the Inspector during and at the end of the guarantee period. Replacements shall be subject to all requirements stated in this specification. The Contractor shall make all necessary repairs to grades, grassed areas, and terrace paving required because of grass replacement at no cost to the City.

D) Final Inspection and Acceptance:
At the end of the guarantee period and upon written request of the contractor, the Inspector will inspect all guaranteed work for final acceptance. The written request shall be submitted to the City ten(10) days prior to the anticipated date of inspection.

Acceptance of hydromulching lawn as herein specified shall be based on a uniform stand of grass and a uniform grade at the time of final inspection. Area of two square feet or more that are bare or have a poor stand of grass and area not having a uniform grade for any cause before final inspection shall be regraded, rehydromulched and reseeded as specified at the Contractor's expense.

Upon completion by the Contractor of all repairs or renewals which may appear at that time to be necessary in the judgment of the City or its authorized representative, the final acceptance of the hydromulching will be issued.

MEASUREMENT:

Measurement of acceptable "Hydromulching", complete in place, shall be made by the square yard [square meter] and only for those areas designated on the plans, or for other areas directed by the Inspector. Fertilizers, wood cellulose fibers, seeds, herbicide and water will not be measured for payment.

BID ITEM:

Item 520: Hydromulching - per square yard [square meter]. (Residential or Commercial)

ITEM 522
SIDEWALK PIPE RAILING

This item shall govern for furnishing and installation of railings for structures, in conformity with the lines, dimensions and details shown on the plans, and with the conditions of these specifications. This item shall include all connections, parts, and accessories, all required anchorage in the structures, headwalls, and wingwalls for proper anchorage of the post.

MATERIALS:

Sidewalk pipe railing shall consist of two (2) horizontal steel pipe rails and vertical posts furnished and installed, complete on structures in conformity with the lines, diameters, dimensions and details shown on the plans and with the conditions of these specifications. This item shall include all connections, parts and accessories, all required anchorage in the structure concrete required for proper anchorage of the post. The pipe shall be of structural steel conforming to the requirements of the Standard Specifications for Steel for Bridges and Buildings, ASTM A36, or approved equal.

Sidewalk pipe railing shall be painted with one (1) shop coat of red primer, and two (2) field coats of aluminum paint. All paints and painting done under this item shall comply with the requirements as set forth under item 514, "Paint and Painting".

CONSTRUCTION METHODS:

Railing shall be constructed of the type specified, in accordance with details shown on the plans, and in conformance with the requirements herein specified. It shall be constructed to the alignment, grade and camber as designated on the plans. Shop fabricated railing shall be of such uniformity as to insure good joints and continuous lines after the falsework for the span has been released. The finished railing shall be rigidly fixed in position and true to line and free of scratches and other defects which would mar the appearance.

MEASUREMENT:

"Sidewalk Pipe Railing", including all painting, anchorage, parts, and connections, in place in accordance with the plans and specifications, complete and accepted will be measured upon the face of the rail in place, from center to center of end post.

PAYMENT:

Payment for railing, measured as prescribed above, will be made at the contract unit price bid per linear foot [meter] for "Sidewalk Pipe Railing, which price shall be full compensation for the furnishing of all labor, material, tools, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

BID ITEM

Item 522: Sidewalk Pipe Railing - per linear foot [meter].

ITEM 523
ADJUSTING OF VEHICULAR & PEDESTRIAN GATES

This item shall govern for the adjustment of Vehicular & Pedestrian Gates made necessary by the construction of new driveways or sidewalk entrances.

MATERIALS:
All additional materials needed to perform the gate adjustment shall conform to those specified in Item 507 - CHAIN LINK WIRE FENCE.

CONSTRUCTION METHODS:
Approval from the property owner shall be obtained by the Inspector, in order to perform the necessary work required. The Contractor shall remove the existing gate from the gate posts, relocate and/or replace (if necessary) the existing hinges at a level such that the gate will provide the necessary clearance to properly operate. In addition, the center rest shall be lowered, if necessary. Then the gate shall be reinstalled and shall be operative.

MEASUREMENT:
Vehicular and pedestrian gates will be measured for each driveway or sidewalk entrance and/or exit of each type that is adjusted.

PAYMENT:
The work performed and the materials furnished as prescribed by this item will be paid for at the bid price per gate for "Adjusting of Vehicular & Pedestrian Gates", which price shall be full compensation for removing and reinstalling the existing gate and for furnishing all additional materials, all labor, tools, equipment and incidentals necessary to complete the work.

BID ITEM
Item 523.1: Adjusting Vehicular Gates - per opening.
Item 523.2: Adjusting Pedestrian Gates - per each

ITEM 524
CONCRETE STEPS

This item shall govern the installation of concrete steps composed of Portland Cement concrete, constructed as herein specified on an approved subgrade, in conformity to the lines, grades and details shown on the plans or as established by the Engineer.

MATERIALS:

1. Concrete: All concrete shall conform to the provisions of Item No. 300, "Concrete (Class-A)" or shall be of the class as noted on the plans.

2. Reinforcing Steel: All reinforcing steel shall conform to the provisions of Item No. 301, "Reinforcing Steel".

3. Welded Wire Flat Sheets: All welded wire flat sheets shall conform to the provisions of Item No. 303, "Welded Wire Flat Sheets".

4. Expansion Joint Materials: All expansion joint materials shall conform to the provisions of Item 304, "Expansion Joint Materials".

5. Membrane Curing Compound: All membrane curing compound shall conform to the provisions of Item 305, "Membrane Curing".

CONSTRUCTION METHODS:

The subgrade shall be excavated and shaped to the lines, grades and cross section shown on the plans, or as directed by the Engineer, and shall be thoroughly compacted. A cushion, 2 inches [50 mm] minimum thickness, of crusher screenings, gravel, crushed rock or flex base material shall be spread, thoroughly, tamped and leveled. The cushion shall be moist at the time the concrete is placed.

If the subgrade is undercut, or the natural ground is below "top of subgrade" then necessary backfill shall be made with an approved material and compacted with a mechanical tamper. Hand tamping will not be permitted.

Where the subgrade is rock or gravel, seventy (70) percent of which rock, the 2 inch [50 mm] cushion need not be used. The Inspector will determine if the subgrade meets the above requirement.

Forms shall be of metal or well-seasoned wood of a section satisfactory to the Inspector; clean, straight,

free from warp, and of a depth equal to the thickness of the finished work. All forms shall be securely staked to line and grade and maintained in a true position during the depositing of concrete. Before concrete is placed, forms shall be thoroughly oiled with a light form oil.

Expansion joint material, 1/2 inch [13 mm] thick, shall be provided where the new construction abuts the existing sidewalks if the Inspector deems it necessary. The expansion joint material shall be placed vertically and shall extend the full depth of the concrete. Similar expansion material shall be placed around all obstructions protruding through the steps.

Concrete steps shall be reinforced as shown on the plans. Care shall be exercised to keep all steel in its proper position during the depositing of concrete. Splices in the No. 3 bars shall have a minimum lap of 12 inches (305 mm).

Concrete shall be placed in the forms and spaded, tamped and thoroughly compacted until mortar entirely covers the surface and has a monolithic finish. The top surface shall be floated and troweled to a uniform smooth surface, then finished with a camel hair brush or wood float to a gritty texture. The outer edges and joints shall be rounded with approved tools to the radii shown on the plans.

Immediately after finishing, the surface shall be protected by a membrane-compound curing agent, or by wetted cotton or burlap mats. Either method shall be subject to approval by the Inspector.

All necessary excavation, filling and grading of the slopes, adjacent to the completed concrete steps, will be considered incidental work pertaining to this item, and will not be paid for directly. The adjacent excavation and grading of the slopes shall be done in a manner acceptable to the Inspector.

MEASUREMENT:

Accepted work as performed as prescribed by this item will be measured by the cubic yard [cubic meter] of concrete complete in place.

PAYMENT:

The work performed as prescribed by this item will be paid for at the contract unit price bid per cubic yard [cubic meter] for Concrete Steps which price shall be full compensation for preparing the subgrade; for furnishing and placing all materials including all reinforcing steel and expansion joint materials and for any other materials, manipulation, labor, tools, equipment and incidentals necessary to complete the work.

BID ITEM

Item 524: Concrete Steps - per cubic yard [cubic meter].

ITEM 525
CONCRETE TRAFFIC BARRIER (PORTABLE)

This item shall govern for furnishing and placing precast concrete traffic barrier at the locations designated in the plans. Precast barrier furnished by the Contractor shall be constructed in accordance with the most current standards of the Texas State Department of Transportation (TXDOT), as may be amended from time to time.

MATERIALS:
All materials used in the construction of precast concrete traffic barrier shall conform to the requirements of Item 307, "Concrete Structures".

CONSTRUCTION METHODS:
Prior to the beginning of casting, the Contractor shall give the City ample notice as to the location of the casting site and the date on which the work will begin.

The barrier sections shall conform to the dimensions and cross sections shown in the latest TXDOT standards for barrier rail portable and precast. Steel forms shall be used. Formwork shall be in accordance with Item 307, "Concrete Structures". The bottom surface of the barrier shall have a rough texture similar to a wood float finish.

Mixing, placing, and finishing of concrete shall be in accordance with Item 307, "Concrete Structures". Concrete shall be form cured or water cured for a minimum of four curing days or may be cured according to Item 30, "Membrane Curing".

Forms may be removed after the concrete has reached sufficient strength to prevent physical damage to the member. Curing shall not be interrupted for more than 30 minutes. When strength requirements have been met, the barrier sections may be moved to a storage area and placed on blocking to prevent damage.

Concrete traffic barriers shall be installed at the edge of the roadway where the drop off to excavation exceeds a three feet [1 m] differential from top of roadway surface. The interface between adjacent barriers shall be interlocking. Installation shall be performed such that an impact by a vehicle typically traversing that stretch of roadway shall not cause the barrier to be moved. The ends of the concrete barrier system must be flared or for no direct payment approved guardrail terminal section or crash cushions may be used. No action associated with the concrete traffic barriers shall violate any portion of the Texas Manual on Uniform Traffic Control Devices.

DEFECTS AND BREAKAGE:
Concrete traffic barrier, including any required hardware, damaged or lost in the process of fabricating, curing, handling, or placing shall be repaired or replaced as directed by the Traffic Engineer. All replacements and repairs shall be made at the Contractor's expense.

MEASUREMENT:
Measurement of the concrete traffic will be by the linear foot [meter], based on the nominal lengths of the barrier segments as shown in the plans. Barriers shall remain the property of the contractor after usage.

PAYMENT:
The work performed and materials furnished and measured as provided above will be paid for at the Unit price bid for "Concrete Traffic Barrier (Portable)", which price shall be full compensation for furnishing, installing the barrier, including the furnishing of all materials, and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work. Additionally, included under this item shall be for any reuse, relocating, or removing the barriers as directed by the Traffic Engineer for the duration of the project

BID ITEM:
Item 525: Concrete Traffic Barrier (Portable) - per linear foot [meter].

ITEM 526
FIELD OFFICE

This item shall govern the erection or furnishing of a building to be used by the inspection force as a Field Office where the contract amount is one million dollars or greater.

GENERAL REQUIREMENTS:

The structure to be furnished by the Contractor shall be of the type described in this item or as described in the plans.

The building shall be provided immediately after work on the project is begun and shall remain in place until the project is accepted by the City as complete, unless its' earlier removal is authorized by the Engineer. It shall be floored and roofed, weather tight and constructed in a workmanlike manner. All windows shall be screened. This building shall be constructed or furnished near the site of the work, at a location acceptable to the Engineer and shall be an independent unit, detached from any office, storage or warehouse building occupied by the Contractor. The building shall be for the sole use of the inspection force.

Should the building be destroyed or damaged in any manner, except through causes due to negligence of the occupying inspecting force, the Contractor shall immediately restore it to its original state. Upon completion of the project, the building will become the property of the Contractor and shall be removed from the project site.

The building shall be a minimum of 10 feet [3 m] by 16 feet [4.8 m] by 8 feet [2.5 m] high with not less than three glass windows and one door.

A table not less than 3 feet [1 m] wide and 8 feet [2.5 m] long plus two chairs shall be provided.

Unless specified otherwise on the plans, the structure for the field office shall be electrically wired with lights, outlets and plugs and have a unit or units for cooling and heating of said structure. A telephone shall be provided for use by the inspection force for local calls. The building shall be serviced with sewer or septic tank with connections and shall contain a restroom with a minimum of a flush toilet and a lavatory. A portable toilet may be furnished and serviced in lieu of a flush toilet. The contractor will be responsible for adequate collection and disposal of trash.

A rental building or office, meeting the specified minimum requirements at a suitable location acceptable to the Engineer may be furnished by the Contractor instead of the building prescribed in this item.

MEASUREMENT AND PAYMENT:

No measurement or payment will be made under this item. The Field Office is not a pay item and shall remain the property of the contractor after completion of this project.

ITEM 530
BARRICADES, SIGNS, AND TRAFFIC HANDLING

This item shall govern for providing, installing, moving, repairing, maintaining, cleaning and removing upon completion of work, all barricades, signs, cones, lights and other such type devices and of handling traffic as indicated on the plans or as directed by the Engineer.

CONSTRUCTION METHODS:

All barricades, signs, and other types of devices listed above shall conform to the requirements of the Texas Manual on Uniform Traffic Control Devices (TMUTCD). It is the contractor's responsibility to see that all traffic control devices are properly installed and maintained at the jobsite. If it is determined by the Traffic Engineering Representative that the traffic control devices do not conform to the established standards, or are incorrectly placed to protect the general public, the Traffic Engineer shall have the option to stop the work, at no expense to the City, until the situation is corrected by the Contractor. If it is determined that additional temporary traffic control devices, special directional devices, and/or business name signs are required, they will be provided by the contractor at no additional cost. As work progresses, the location of temporary traffic control devices will be adjusted and modified as necessary by the Contractor.

All retroreflective traffic control devices such as barricades, vertical panels, signs, etc., shall be maintained by cleaning, replacing or a combination thereof such that during darkness and rain, the retroreflective characteristics shall equal or exceed the retroreflective characteristics of the standard reflective panels in the Inspector's possession.

The contractor shall contact the City of San Antonio Traffic Operations Section prior to removing any traffic signs or traffic signals. Prior to completion of the contract and removal of barricades, all applicable permanent traffic signs and signals must be in place and functioning properly. All permanent signs or traffic control devices missing or damaged during construction shall be replaced at the contractor's expense. Permanent pavement markings shall be applied prior to the opening of any street to traffic. Temporary short-term expendable pavement markings may be provided prior to application of permanent markings.

The contractor must maintain all streets open to through traffic by repairing trenches, potholes, etc., at no direct payment. The contractor shall provide reasonable access to residences and all businesses within all phases of the work, as well as providing suitable access accommodations for school children, pedestrians, garbage pick-up and mail delivery by the U.S. Postal Service. Temporary pedestrian crossing will be determined in the field by the Police Department Accident Prevent Bureau. Temporary pedestrian crossings shall be 4 feet [1.2 m) wide by 4 inches [102 mm] thick asphalt treated base and will be paid for under Item 206.

MEASUREMENT:

This item will be measured by the unit of measure "month" as indicated on the plans.

PAYMENT:

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Barricades, Signs and Traffic Handling". This price shall be full compensation for furnishing all labor, materials, supplies, equipment and incidentals necessary to complete the work as specified.

Payment will be made on the following basis:

(1) The total payment for this Item will not exceed 10 percent of the total contract amount prior to "Final Acceptance". The portion of the contract amount for this Item in excess of 10 percent of the total contract amount, less any adjustments as specified below, will be paid on the next monthly estimate cycle after the retainage estimate.

(2) Payment for this Item will begin on the first payable monthly construction estimate after barricades, signs and traffic handling devices have been installed and construction has begun.

(3) Monthly payment will be made each succeeding month for this Item provided the barricades, signs and traffic handling devices have been installed and maintained until the contract amount for Barricades, Signs and Traffic Handling has been paid unless adjusted by paragraph (4).

(4) The quantity under this Item will not exceed the total plan quantity except when additional work is added by an approved field alteration or extra work order. Also when work is suspended for the convenience of the City, through no fault of the

Contractor, additional quantity may be paid when approved by field alteration.

(5) An overrun of the plan quantity for this Item will not be allowed for approving designs, testing, material shortages, closed construction seasons, curing periods, test periods, failure to complete the work prior to payment of the amount allowed by (1) and (3) above nor delays caused directly or indirectly by requirements of the contract.

(6) If the contract is completed prior to payment of the amount allowed by (1), (3) and (7), the balance due will be paid on the semi-final estimate. When the plans establish pay items for particular work called for in the plans, that work will be measured and paid for under the governing items.

(7) If the Contractor fails, within the time frame established by the Inspector, to provide or properly maintain signs and barricades in compliance with the contract requirements, the Contractor will be considered in non-compliance with this Item and no payment will be made for this Item for the month(s) in question.

BID ITEMS:

Item 530: Barricades, Signs and Traffic Handling - per month.

ITEM 531
SIGNS

This specification applies to the furnishing of retroreflective and non-retroreflective signs constructed of aluminum substrate to the dimensions specified and the installation of signs of varying sizes and legends as shown on the plans or as specified by the Traffic Design Engineer.

MATERIALS:

Subtrate:

This shall be aluminum alloy 5052-H38 and otherwise in conformance with ASTM B-209 and have gold chromate finish. The size, shape and thickness of the sign blanks are as indicated on the standard detail sheet in the plans or as specified by the Design Engineer.

(A) Metal working: The aluminum shall be free of burrs and pits on both sides, including edges and holes, and shall be made ready for applications of the sheeting.

(B) Surface Preparation: The aluminum shall be thoroughly cleaned and degreased with solvent and alkaline emulsions cleaner by immersion, spray, or vapor degreasing and dried prior to application of the gold chromate sheeting coat. The aluminum shall be new and corrosion-free with holes drilled or punched, corners rounded to the radii shown in the standard detail sheet, and all edges smoothed prior to application of sheeting. The heavy or medium chromate coating shall conform in color and corrosion resistance to that imparted by the Alodine 1200F treatment.

(C) Size: The dimensions of substrate applications for regulatory, warning, and guide signs will be as specified by the Design Engineer and as shown on the plans.

BACKGROUND, LEGENDS, SYMBOLS AND COLORS:

These shall be in accordance with the Standard Highway Sign Designs (SHSD) for Texas and with the Texas Manual of Uniform Traffic Control Devices (TMUTCD).

(A) Retroreflective Materials: Retroreflective materials shall comply with "Standard Specifications for construction of Roads and Bridges on Federal Highway Projects", FP-85 and Federal Specifications L-S-300C. The Contractor shall furnish a certification that the materials comply with the requirements of FP-85 and L-S-300C.

(1) Retroreflective Sheeting - Type II (Engineer Grade): The materials as listed in these specifications shall comply with FP-85, Section 718 and L-S-300C.

Colors shall be as specified in specifications for Standard Highway Sign Colors (FHWA, HTO-21).

(2) Retroreflective Sheeting - Type III (High Intensity): The materials as listed in these specifications shall comply with FP-85, Section 718 and L-S-300C.

Colors shall be as specified in specifications for Standard Highway Sign Colors (FHWA, HTO-21).

(B) Non-Retroreflective Sheeting: All letters, numerals, and symbols shall be as prescribed in this specification.

(C) Application Methods: The method of application of sheeting, letters, numbers, and symbols shall be precisely as prescribed in writing by the manufacturer.

(1) Silkscreening – Letter styles shall conform to specifications for die-cut legend in this specification. Screen processing when used, shall be of careful workmanship with neat, clean lines and corners, performed strictly as prescribed by the manufacturer of the transparent, opaque or screen colors. The inks shall be drawn over the screen with a firm, even pressure. As needed, three to five minutes shall be allowed for the ink to flow out so that it has a smooth surface.

(2) Direct Application – The applicator diaphragm shall have at least two pyrometers centrally attached. The applicator shall also have a cycle control unit approved by the sheeting manufacturer.

Temperature control calibration and accuracy monitoring of the approved cycle control unit shall be required each day that the heat and vacuum applicator is operated. Applicator operating temperature shall be calibrated with the specific temperature measuring device each day of operations, and

1. Whenever different substrate materials are being used.

2. Whenever a diaphragm, light bulb, cycle-control unit, or thermocouple is replaced.

3. Whenever different types or different colors of retroreflective sheeting are used.

(3) Legend spacing and Layout – Spacing and layout for all traffic control signs shall conform to the SHSD.

(a) Tolerance for Horizontal Alignment: Letters, numerals, and symbols shall be horizontally aligned to a tolerance of 1/16 inch [1.5 mm]. Test of each sign board shall be as follows:

Place a metal straight edge along the bottom of a series of letters forming each line of the sign. In each line, letters shall not vary more than 1/16 inch [1.5 mm] from that line.

(b) Tolerance for Vertical Alignment: Letters, numerals, and symbols shall be vertically aligned to a tolerance of 1/16 inch [1.5 mm]. The following tests shall be performed on each letter in each line:

Place a metal straight edge along the bottom edge of a series of letters forming each line of the sign. Place a square along the straight edge and test the trueness of the vertical faces of individual letters. Letters shall be normal to the square within 1/16 inch [1.5 mm].

SIGN POSTS:
Posts shall be "high visibility yellow traffic posts". Outside diameter shall be 2.375 inches [60 mm]; wall thickness shall be .065 inch [1.6 mm]; weight shall be 1.064 pounds per foot [1.58 kg/m]; length shall be 11 or 12 feet [3.4 m - 3.6 m] with 12 holes, 3/8 inch [9 mm] in diameter, drilled to specifications as indicated in the standard details. The post shall be welded steel tubing conforming to ASTM specification A-513 made from hot-dipped galvanized sheet metal conforming to ASTM specification A-525 or the tube may be hot-dipped galvanized sheet metal which is a G-90 commercial weight. The color shall be "High Visibility Traffic Yellow". Yellow coating shall be applied over the galvanized post to a minimum dry thickness average of 2.5 mils.

(A) Flange: When sign post installation is required over building basements, bridges and cavities, a cast iron pipe flange shall be used. The base shall be 8 inches [203 mm] in diameter with six 5/16 inch [7.5 mm] holes drilled equidistant around the circumference, 5/8 inch [15 mm] from the outer edge. The neck of the flange shall be 3 inches [76 mm] in diameter, drilled and threaded to receive a 2 inch [50 mm] diameter galvanized post.

(B) Hardware: All bolts shall be stainless-steel, theft-resistant, 5/16 inch x 3 inches [7.9 mm x 76 mm]. Stainless steel banding material, brackets and clips will be used for signs installed on light standards or mast arms.

(C) Construction: Poles shall be anchored in a minimum of one cubic foot [0.03 cubic meters] of class "C" concrete, 18 inches [457 mm] deep, with a 6 inch [152 mm] long, 3/8 inch [9 mm] diameter pin inserted through the pre-drilled hole 3 inches [76 mm] from the bottom of the pole. Where the pole installation requires surface mounting, an 8 inch [203 mm] flange with a 2 inch [50 mm] threaded collar shall be used. The pole shall be galvanized, two inches [50 mm] in diameter and threaded to fit the flange. Sign placement and orientation shall be as specified in the construction plans.

ANTI-VANDALISM AND MAKER'S MARK DECALS:
The antivandalism decal shall be installed on the back bottom left corner of the sign. Decals will be supplied by the Traffic Operations Section (207-7765). Each sign shall be permanently marked on the lower right corner of the back side with the month and year of installation, and name of manufacturer.

WARRANTY:

The Contractor shall warrant the materials and workmanship of each sign in accordance with the maximum limits of material warranties extended by manufacturers of raw materials, subject to the conditions they specify. Type II and III sheetings processed and applied to sign blank materials in accordance with sheeting manufacturer's recommendations, shall perform effectively for the number of years stated in Table I of this specification. The retroreflective sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving

conditions; or (2) the coefficient of retreoreflection is less than the minimum specified for that sheeting during that period
listed in Table I. When sign failure occurs prior to the minimum years indicated and an inspection demonstrates that the failure is caused by materials warranted to contractor to endure at least that long, the sign will be replaced or repaired free of materials charges. When failure occurs and inspection demonstrates that such failure is due to poor workmanship, the sign will be replaced or repaired at Contractor's expense, including shipping charges.

TABLE I
Minimum Coefficient of Retroreflection
Candelas per Foot -Candle per sq. Ft.
(.2° observation angle and -4° entrance angle)

Type II and III Sheetings

Life Span	7 years	10 years
Sheeting Color:		
White	212	200
Yellow	144	136
Green	38	36
Red	38	36
Blue	17	16
Brown	10	9

For screen printed transparent colored areas on white sheeting, the coefficients of retroreflection shall not be less than 70% of the values for the corresponding color in the above table.

CONSTRUCTION METHODS:

If a signalized intersection has either mast arms or span-wire on which overhead street name signs an be attached, no ground mounted streets name signs are required at that intersection. Street name signs shall always be supplied and installed at each project intersection whether signs previously existed at the location or not. Overhead street name signs shall be 12 inches [305 mm] high with 6 inch [152 mm] letters and shall be installed on all approaches. Signs shall be bolted or strapped to the mast arm or span wire. Attachments to mast arms shall be by means of a 5/8 inch [15 mm] stainless steel strap and a stainless steel flared strap bracket. At unsignalized intersections, ground-mounted street name signs of 9 inch [229 mm] heights are required. However, if all of the intersecting streets at a given unsignalized intersection, have speed limits less than 35 mph [56 kph], all street name signs at that intersection shall be 6 inches [152 mm] high.

Construction shall be high quality with no visible defects in the finished product. Fabrication shall be in accordance with these specifications.

EXISTING SIGNS
The removal of existing signs shall be coordinated with the Traffic Division to assure required signage is in place during all construction phases. When existing signs are to be removed, they will be unbolted from their post by hand and delivered to the Traffic Operations Section (207-7765).

MEASUREMENT AND PAYMENT:

Measurement shall be based on the number of satisfactorily installed signs.

The accepted quantities shall be paid at the contract unit price for the sign type applicable in the bid list which shall be full compensation, furnishing of all materials, labor, tools, equipment, and supplies to construct signs of varying sizes and legends as shown on the plans or as specified by the Traffic Design Engineer.

BID ITEMS:

Item 531.01: 12 inch [305 mm] Metro Street Name

Item 531.02: 18 inch [457 mm] Metro Street Name

Item 531.03: R1-1 STOP

Item 531.04: R1-2 YIELD

Item 531.05: R1-4 ALL WAY plate

Item 531.06: R2-1 Speed Limit

Item 531.07: R3-1 No Right Turn

Item 531.08: R3-2 No Left Turn

Item 531.09: R3-3 NO TURNS

Item 531.10: R3-4 No U-Turns

Item 531.11: R3-5 Left or Right Only

Item 531.12: R3-6 Lane-Use Control

Item 531.13: R3-7 LEFT LANE MUST TURN LEFT or RIGHT LANE MUST TURN RIGHT

Item 531.14: R3-8 Lane-Use Control

Item 531.15: R3-8 U-Turn Only

Item 531.16: R3-9 Two Way Left Turn Only

Item 531.17: R4-7 Keep Right

Item 531.18: R5-1 DO NOT ENTER

Item 531.19: R6-1 ONE WAY

Item 531.20: R6-2 ONE WAY

Item 531.21: R7-1 NO PARKING ANYTIME

Item 531.22: R7-18 NO PARKING THIS SIDE

THIS BLOCK

Item 531.23: R7-32 LOADING ZONE

Item 531.24: R9-3a Pedestrian Crossing Prohibited

Item 531.25: R10-11 NO TURN ON RED 7-9 AM AND 2-4 PM, SCHOOL DAYS ONLY

Item 531.26: R10-11a NO TURN ON RIGHT

Item 531.27: R10-12 LEFT TURN YIELD ON "Green Ball"

Item 531.28: R10-5 LEFT ON ARROW ONLY

Item 531.29: R10-6 STOP HERE ON RED

Item 531.30: R10-7 DO NOT BLOCK INTERSECTION

Item 531.31: S-25 NO PARKING 7-9 AM AND 2-4 PM SCHOOL DAYS ONLY

Item 531.32: S-26 NO PARKING 7-9 AM AND 2-4 PM STUDENT LOADING, SCHOOL DAYS ONLY

Item 531.33: S-27 NO PARKING 7-9 AM AND 2-4 PM SCHOOL BUS ZONE

Item 531.34: S1-1 Advance School Crossing

Item 531.35: S2-1 School Crossing

Item 531.36: S4-1 School Speed Limit

Item 531.37: W1-1 Turn

Item 531.38: W1-2 Curve

Item 531.39: W1-3 Reverse Turn

Item 531.40: W1-4 Reverse Curve

Item 531.41: W1-5 Winding Road

Item 531.42: W1-6 Large Arrow

Item 531.43: W1-7 Large Arrow

Item 531.44: *No sign Assigned to this Item*

Item 531.45: W1-8 Chevron Alignment

Item 531.46: W3-3 Signal Ahead

Item 531.47: W4-2 Lane Reduction Transition

Item 531.48: W8-1 BUMP

Item 531.50: W8-2 DIP

Item 531.51: W9-2 Merge

Item 531.52: W10-1 Railroad Advance Warning

Item 531.53: W11a2 Ped Crossing

Item 531.54: W13-1 Advisory Speed

Item 531.55: W14-1 DEAD END

Item 531.56: W14-2 NO OUTLET

Item 531.57: OM-3 Type 3 Object Marker

Item 531.58: OM-4 End of Road Marker

Item 531.59: 9 inch [229 mm] Street Name

Item 531.60: 6 inch [152 mm] Street Name

Item 531.61: Special Sign

ITEM 533
STRIPING OBLITERATION

The purpose of this specification is to describe a procedure for cleaning of surfaces prior to the placement of pavement markings and/or for removal of existing pavement markings.

MATERIALS:

The blasting medium shall be quality commercial product capable of producing the specified surface cleanliness without the deposition of deleterious materials on the cleaned surface.

All equipment shall be of sufficient capacity to efficiently and economically clean the roadway surface to the specified cleanliness. Equipment shall be power driven and in good operating condition. Equipment shall utilize moisture and oil traps, in working order, of sufficient capacity to remove contaminants from the air and prevent deposition of moisture, oil or other contaminants on the roadway surface.

CONSTRUCTION METHODS:

Widths, lengths, and shapes of the blast-cleaned surface shall be of sufficient size to include the full area of the specified pavement marking to be placed or removed. Surface cleaning shall be done on all existing pavements where the inlaid plastic material is not being used with new pavement.

Blast cleaning on portland cement concrete surfaces shall be sufficient to remove old pavement markings and all other contaminants. Over-blasting to the extent of damage to the roadway surface shall be avoided. Very small particles of tightly adhering existing markings may remain in place if complete removal of the small particles will result in pavement damage.

All surfaces other than portland cement concrete surfaces required to be cleaned shall be blasted sufficiently to remove loose and flaking conditions or markings of the road surface.

Existing markings to be removed shall be removed to the extent that the pavement marking is either completely removed or obliterated.

MEASUREMENT AND PAYMENT:

Striping obliteration shall not be paid for directly, but shall be considered subsidiary to the pavement marking items or Mobilization if no pavement marking pay items are used.

This specification is included in this project solely as a technical guide as to how striping obliteration shall be done and does not constitute a separate bid item.

ITEM 535
HOT APPLIED THERMOPLASTIC PAVEMENT MARKINGS

This specification describes the minimum optical and physical properties required for a thermoplastic road marking compound that is to be applied in a molten state, onto a pavement surface, to provide traffic stripes and/or markings.

The appearance of the finished markings shall have a uniform surface, crisp edges with a minimum over-spray, clean cut-off, meet straightness requirements and conform to the design drawings and/or engineer instructions.

MATERIALS:

Thermoplastic pavement marking material shall be a product especially compounded for traffic markings for use on either asphaltic or portland cement concrete surfaces.

The following composition requirements shall be met:

	White	Yellow
Binder	18% Min.	18% Min.
Ti02 (Type 2 Rutile)	12% Min.	N/A
Glass Spheres	48% Min.	48% Min.
Yellow Pigment	N/A	10% Min.

BINDERS:
The alkyd binder shall consist of maleic modified rosin ester and other plasticizers.

PIGMENT:
The yellow pigment used shall be an encapsulated type of heat stabilized medium lead chromate pigment with a minimum of 50% lead content or other approved heat resistant pigment.

PHYSICAL REQUIREMENTS:
The Meltdown Procedure for Thermoplastic, available from the Engineer, shall be used when conducting laboratory tests to verify the following property requirements.

COLOR:
The white thermoplastic shall be pure white and free from any tint. Using a Colorimeter, such as a Gardner color Difference Meter, the material shall not show deviations from a magnesium oxide color standard that are greater than the following:

Scale Definition	Magnesium Oxide Standard	Sample
RD	100	75%
Reflectance		
a Red-Green	0	-5 to +5
b Yellow-Blue	0	-10 to +10

The color of the yellow thermoplastic shall visually match that of FHWA PR Color #1. The daytime reflectance values and chromaticity coordinates, shall fall within the following limits:

Reflectance	45% Min.			
Chromaticity Coordinates x and y	Shall fall in an area border by these Coordinates:			
x	0.470	0.510	0.490	0.537
y	0.455	0.489	0.432	0.462

COLOR RETENTION:
The thermoplastic materials shall maintain the color values specified in the above section for white and yellow after 72 hours of exposure to the following test: Samples shall be prepared and subjected to an ultraviolet light source as described in ASTM test method D-795.

Note: A General Electric 275 watt sun lamp (Type RS) with a built-in reflector, may be substituted for the light source.

WATER ABSORPTION:
When tested in accordance with test method ASTM D-570, the thermoplastic compound shall have no more than 0.5% by weight, of retained water.

SOFTENING POINT:
When tested in accordance with test method ASTM E-28, the compound shall have a softening point of not less than 90°F [32 °C].

LOW TEMPERATURE STRESS RESISTANCE:
A test sample shall not crack or fail to adhere to a concrete substrate when subjected to the following low temperatures test:

A concrete substrate coated with a minimum of 32 square inches [613 mm^2] of thermoplastic material shall be immersed in cold water for one hour; then immediately placed in an insulated cold compartment and maintained at a temperature of minus 10 °C for a period of 24 hours. When removed and allowed to come to room temperature, the sample shall show no cracking or flaking from the concrete substrate.

SAFETY:
At the recommended application temperature, the material shall not give off fumes that are toxic or otherwise injurious to persons or property.

SPECIFIC GRAVITY:
The specific gravity of the compound shall be between 1.9 and 2.3. The water displacement method shall be used to determine specific gravity.

DRYING TIME:
When the material is applied at 400 °F [204 °C], the line shall be completely solid and show no effect of tracking after 15 minutes or at an ambient temperature of 75 °F [24 °C].

INDENTATION RESISTANCE:
The hardness shall be measured by a Shore Durometer, Type A2, as described in test method ASTM D 2240. The durometer and the panel shall be at 45 °C ± 2 °C with a two kilogram load applied, the scale reading shall be between 40 and 75 units after 15 seconds.

ABRASION RESISTANCE:
When tested by the abrasive blasting method, the sample shall show a maximum material loss of eight grams.

IMPACT RESISTANCE:
When tested according to Method A of ASTM Test Method D 256-71a, the average impact resistance of 4 separate samples shall not be less than 10 inch-pounds (1751 N/m).

REHEATING:
The thermoplastic compound shall maintain the proper physical properties outlined above, when heated to 425° F [220 °C] for up to six hours. After heating to 425°F [220 °C] for 6 hours while continually stirring at 50 to 100 RPM, the Brookfield viscosity shall not exceed 18,000 centipose at 12 RPM.

GLASS SPHERES:
REFRACTIVE INDEX: The reflective glass spheres, premixed into the compound and the reflective glass spheres used for surface application shall have a refractive index of not less than 1.50 when tested by the liquid immersion method at 25 °C.

ROUNDNESS: When tested according to ASTM Method D-155, a minimum of 75 percent of the glass spheres premixed into the compound and the reflective glass spheres used for surface application shall be true spheres.

GRADATION: The glass spheres both premixed into the compound and used for surface applications shall meet the gradation requirements of AASHTO M-247, Type 1, as follows:

ASHTO M-245 GRADATION

Sieve Size	Percent Passing
20	100%
30	75 to 95%
50	15 to 35%
100	5 to 5%

INTER-MIX BEAD COATING: The glass spheres premixed into the compound shall have an adhesion promoting coating which is specific for the thermoplastic system. The presence of a coating specific to Thermoplastic system shall be determined by testing for the detection of a silane adhesion coating on intermix glass spheres.

DROP-ON BEAD COATING:
Moisture Resistance: The glass spheres for surface application shall be resistant to clumping caused by moisture and shall pass the moisture resistance test described in a subsequent section of this document.

The glass spheres must pass this moisture resistance test before being tested for the following anti-wicking and adhesion properties.

Anti-wicking (Flotation): The glass spheres for surface application, which have passed the moisture resistance test shall be tested for anti-wicking by the attached Test Method for flotation and anti-wicking.

The anti-wicking properties of the glass spheres shall be demonstrated if the spheres exhibit retroreflection on the surface of the thermoplastic material.

Adhesion: The glass spheres for surface application that have passed both the moisture resistance test and the Anti-wicking test shall be capable of adhering to the surface of the plastic as determined by the attached Test Method for bead adhesion.

When tested by this procedure, a minimum of the 75% of the beads shall remain bonded to the surface of the thermoplastic.

APPLICATION:

SURFACE PREPARATION:
MOISTURE: All surfaces shall be inspected for moisture content prior to application of thermoplastic. Approximately two square feet of a clear plastic or tar paper shall be laid on the road surface and held in place for 15 to 20 minutes. The underside of the plastic or tar paper shall then be inspected for a build up of condensed moisture from the road surface. If the amount of condensed moisture is of a sufficient amount to result in water dripping from the plastic or tar paper when held in a vertical position, thermoplastic shall not be applied. This moisture test shall be repeated until the moisture in the road surface has been allowed to evaporate to a level whereby there is not excessive build up of condensed moisture on the underside of the plastic or tar paper.

CLEANING: All surfaces shall be clean and dry before thermoplastic can be applied. Loose dirt and debris shall be removed by blowing compressed air over the area to be striped. If the thermoplastic is to be applied over existing paint lines, the paint line shall be swept with a mechanical sweeper or wire brush to remove poorly adhered paint and dirt that would interfere with the proper bonding or the thermoplastic. Latence and curing compound shall be removed from all new Portland cement concrete surfaces by loose grain abrasive pressure blasting or wire brushing.

LAYOUT: The pavement markings shall be placed in proper alignment with guidelines established on the roadway. Deviation from the alignment established shall not exceed 2-inches [50 mm] and, in addition, the deviation in alignment of the marking being placed shall not exceed 1-inch [25 mm] per 200 feet [61 m] of roadway nor shall any deviation be abrupt.

Longitudinal markings shall be offset at least 2-inches [50 mm] from construction joints of portland cement concrete surfaces and joints and shoulder breaks of asphalt surfaces.

PRIMER AND SEALER: Primer sealer shall be used on all portland cement concrete surfaces. A primer sealer shall be used on asphalt surfaces that are over two years old and/or on asphalt surfaces that are worn or oxidized to a condition where 50 percent or more of the wearing surface is exposed aggregate.

PRIMER SEALER APPLICATION: When required as described, the primer-sealer shall be applied to the road surface in a continuous film at a minimum thickness of 3 to 5 mils. Before the Thermoplastic is applied, the primer-sealer shall be allowed to dry to a tacky state. The thermoplastic shall be applied with 4 hours after the primer application.

TEMPERATURE REQUIREMENTS:
AMBIENT CONDITIONS: The ambient air and road surface shall be 55 °F [10 °C] and rising before application of thermoplastic can begin.

MATERIAL REQUIREMENTS: The thermoplastic compound shall be heated from 400 °F to 450 °F [204 ° C - 232 °C] and shall be a minimum of 400 °F (204°C) as it makes contact with road surface during application. An infrared temperature gun shall be used to determine the temperature of the thermoplastic as it is being applied to the road surface.

DROP-ON GLASS SPHERE APPLICATION:
APPLICATION RATE: Retroreflective glass spheres shall be applied at the rate of 10 pounds per 100 square feet [4.5 kilograms per 9.5 square meter] of applied markings. This application rate shall be determined by confirming the following consumption rates:

200 pounds [68 kilograms] of drop on glass spheres per ton [1 megagram] of applied thermoplastic when the thermoplastic is being applied at 0.090 inch [2.3 mm] film thickness.

150 pounds [68 kilograms] of drop on glass spheres per ton [1megagram] of applied thermoplastic when the thermoplastic is being applied at 0.125 inch [3.2 mm] thickness.

APPLICATION METHOD: Retroreflective glass spheres shall be applied by a mechanical dispenser property calibrated and adjusted to provide proper application rates and uniform distribution of the spheres across the cross section of the entire width of the line. To enable the spheres to embed themselves into the sphere dispenser shall be positioned immediately behind the thermoplastic application device. This insures that the spheres are applied to the thermoplastic material while it is still in the molten state.

APPLICATION FILM THICKNESS:
HIGH WEAR LONGITUDINAL AND TRANSVERSE MARKING: All lane lines, center lines, transverse markings and pavement markings in high traffic areas shall have a minimum film thickness of 0.125 inch [3.2 mm] at the edges and a maximum of 0.188 inch [4.8 mm] at the center. A minimum average film thickness of 0.125 inch [3.2 mm] shall be maintained.

PACKAGING:
CONTAINERS: The thermoplastic material shall be delivered in 50 pound [23 kilogram] cardboard containers or 50 pound [23 kilogram] bags of sufficient strength to permit normal handling during shipment and handling on the job without loss of material.

LABELING: Each container shall be clearly marked to indicate the color of the material, the process batch number and/or manufacturer's formulation number, the manufacturer's name and address and the date of manufacture.

SAMPLING AND TESTING:
SAMPLING PROCEDURE: Random check samples may be taken at the job site at the discretion of the City Engineer. The City reserves the right to conduct whatever tests are deemed necessary to identify component materials and verify results of specific tests indicated in conjunction with the specification requirements.

The sample(s) shall be labeled as to the shipment number, lot number, date, quantity, and any other pertinent information. At least three randomly selected bags shall be obtained from each lot. A 10 pound [4.5 kilogram]) sample from the three bags shall be submitted for testing and acceptance. The lot size shall be approximately 44,000 pounds [20 megagram] unless the total order is less than this amount.

MANUFACTURER' S RESPONSIBILITY

SAMPLING AND TESTING: The manufacturer shall submit test results from an approved independent laboratory. All material samples shall be obtained 20 days in advance of the pavement marking operations. The cost of testing shall be included in the price of thermoplastic material. The approved independent laboratory's test results shall be submitted to the City Traffic Engineer in the form of a certified test report.

BILL OF LADING: The manufacturer shall furnish the Material and Tests Laboratory with copies of Bills of Lading for all materials inspected. Bill of lading shall indicate the consignee and the destination, date of shipment, lot numbers, quantity, type of material, and location of source.

MATERIAL ACCEPTANCE: Final acceptance of a particular lot of thermoplastic will be based on the following.
A. Compliance with the specification for material composition requirements verified by approved independent laboratory with tests results.
B. Compliance with the specification for the physical properties required and verified by an approved independent laboratory with test results.
C. Manufacturer's test results for each lot thermoplastic have been received.
D. Identification requirements are satisfactory.

CONTRACTOR' S RESPONSIBILITY:

The contractor shall notify the Construction Inspector 72 hours prior to the placement of the thermoplastic markings enable the inspector to be present during the application operation. At the time of notification, the Contractor shall indicate the manufacturer and the lot numbers of the thermoplastic that he intends to use. A check should be made by the contractor to insure that the approved lot numbers appear on the material package. Failure to do so is cause for rejection.

If the normal trade practice for manufacturers is to furnish warranties or guarantees for the materials and equipment specified herein, the Contractor shall turn the guarantees and warranties over to the Engineer for potential dealing with the manufactures. The extent of such warranties or guarantees will not be a factor in selecting the successful bidder.

MEASUREMENT AND PAYMENT:

Measurement shall be based on the length of satisfactorily installed line, in feet [meters], or as appropriate, the number of symbols or words which are satisfactorily installed on the roadway surface by the contractor.

Payment shall be according to the quantities measured for each of the following items:

BID ITEMS:

Item 535-A: 4 inch [102 mm] wide yellow line

Item 535-B: 4 inch [102 mm] wide white line

Item 535-C: 8 inch [203 mm] wide yellow line

Item 535-D: 8 inch [203 mm] wide white line

Item 535-E: 12 inch [305 mm] wide white line

Item 535-F: 16 inch [406 mm] wide white line

Item 535-G: 24 inch [610 mm] wide white line

Item 535-H: Right White Arrow (per each)

Item 535-I: Left White Arrow (per each)

Item 535-J: Combination Thru/Right White Arrow (per ea.)

Item 535-K: Combination Thru/Left White Arrow (per each)

Item 535-L: Word "ONLY" (per word)

Item 535-M: Straight White Arrow (per each)

Item 535-N: Railroad Crossing Symbol, including two R's, crossbuck and 3 transverse bars (per each)

ITEM 536
PREFORMED PLASTIC PAVEMENT MARKINGS

The purpose of this specification is to describe a long-term tape and sheeting pavement marking material to be used for permanent type longitudinal or transverse lines and word/symbol legends.

MATERIALS:

The markings shall be of high quality polymeric materials, retroreflective, skid resistant and have pressure sensitive adhesive for quick and convenient application.

Adhesive material with a liner on the back is not acceptable.

Materials supplied under this specification shall consist of white or yellow films with pigment selected and blended to conform to standard highway colors throughout the life of the film. Glass spheres shall be uniformly distributed throughout the base film and a dressing of glass spheres firmly adhered to the top surface for initial retroreflectivity.

Material shall be capable of being affixed to stable existing bituminous or portland cement concrete pavements, shall mold itself to pavement contours by the action of traffic, and shall be capable of use for patching worn areas of the same type of film in accordance with the manufacturer's instructions. The materials shall also be capable of application of new asphalt concrete wearing course during the paving operation in accordance with the manufacturer's instructions. After application, the marking shall be immediately ready for traffic.

All material shall conform to "Table 1" below:

Written certification shall be supplied to the City verifying that the proposed materials meet these specifications.

All pavement markings shall conform to applicable shapes, colors and sizes as outlined in the current Texas Manual on Uniform Traffic Control Devices for Streets and Highways.

All materials, workmanship, and labor shall be covered by a manufacturer's guarantee and/or warranty for a period of 12 months from the date of field application. If failures occur during this 12 month period, the Contractor shall bear the cost of removal and reinstallation of said materials to the satisfaction of the City.

CONSTRUCTION METHODS:

All markings shall be located as shown in the plans.

The contractor shall install the preformed plastic pavement markings to hot-mix asphaltic concrete pavements by the in-laid method.

All material shall be placed according to the manufacturer's instructions, and in accordance with the surface condition, moisture and temperature requirements listed below:

INLAID PREFORMED PLASTIC PAVEMENT MARKINGS:

This installation procedure shall apply to streets with asphaltic concrete surfacing. For portland cement concrete streets, see Cold-Laid Preformed Pavement Markings (next section) below.

The contractor shall place and inlay all pavement markings on the newly placed asphaltic concrete pavement prior to the final rolling of the asphalt.

The preformed pavement markings shall be applied after the newly placed asphaltic concrete pavement has been adequately compacted and when the asphaltic concrete pavement has attained a temperature range of 125 °F to 155 °F [52 °C - 68 °C]. If the pavement cools to below 125 °F [52 °C], the markings will be installed by the cold-laid method. The Contractor will be required to install temporary pavement markings at no additional cost to the City if the cold-laid method is used. Preformed pavement line markings shall be installed with a mechanical applicator which shall be capable of placing pavement lines in a neat accurate and uniform manner. The mechanical applicator shall be equipped with a film cut-off device. Word legends and arrows shall be installed by hand and result in neat, accurate and uniform words and arrows.

The preformed pavement markings shall be inlaid into the asphaltic concrete surface by means of a mechanical roller. The roller shall be of sufficient weight capacity to inlay the pavement marking to a minimum depth of 65% of the material thickness, and to not more than 80% of the material thickness while the temperature range of the pavement surface is within 120 °F to 155 °F [49 °C to 68 °C]. In the event the inlaid markings are distorted by the contractor's operations, fail to provide a uniform appearance, or are installed improperly, such markings shall be removed and replaced in the finished surface of the pavement at no additional expense to the City.

COLD-LAID PREFORMED PAVEMENT MARKINGS:

This installation procedure applies to portland cement concrete streets.

Pavement on which pavement markings are to be placed shall be cleaned and prepared prior to placement of markings. Cleaning shall be by any effective method that completely removes contaminants, loose materials, and conditions deleterious to proper adhesion. When blast cleaning is required, it shall be done to the extent that a sound pavement surface is exposed. Surfaces shall be further prepared after cleaning by sealing or priming, as recommended by the manufacturer.
Pavement to which materials to be applied shall be completely dry. Materials shall not be applied until concrete pavement has appeared to be dry for a minimum of four hours and until asphaltic concrete pavement has appeared to be dry for a minimum of two hours.

Pavement and ambient air temperature requirements recommended by the manufacturer shall be observed. If no temperature requirements are established by the manufacturer, material shall not be placed if the surface temperature is below 60 °F [16 °C] or if it is above 120 °F [49 °C].

MEASUREMENT AND PAYMENT:

Measurement shall be made by the length of satisfactorily installed line, in feet [meters], the number of and types of symbols and other pavement legends in accordance with the plans and specifications. The accepted quantities shall be paid at the contract unit price for the type of line or legend applicable in the bid list which shall be full compensation for materials, surface preparation, labor and incidentals.

BID ITEMS:

Item 536.1: 4 inch [102 mm] Wide Yellow Line

Item 536.2: 4 inch [102 mm] Wide White Line

Item 536.3: 8 inch [204 mm] Wide Yellow Line

Item 536.4: 8 inch [204 mm] Wide White Line

Item 536.5: 12 inch [305 mm] Wide White Line

Item 536.6: 16 inch [406 mm] Wide White Line

Item 536.7: 24 inch [610 mm] Wide White Line

Item 536.8: Right White Arrow

Item 536.9: Left White Arrow

Item 536.10: Comb. Thru/Rt. Arrow

Item 536.11: Comb. Thru/Lt. Arrow

Item 536.12: Word "ONLY"

Item 536.13: Straight White Arrow

Item 536.14: Complete Railroad marking, including

t
w
o

R
'
s
,

c
r
o
s
s
b
u
c
k
,

a
n
d

t
h
r
e
e

b
a
r
s

Item 536.15: White Diamond

TABLE 1

Characteristics and Test method	Requirements
Minimum Thickness without adhesive	60 mils
Composition (Min. % by Wt.)	
Resins & Conditioners	20%
Pigments & Fillers	30%
Glass Spheres	33%
(The remaining % shall be composed of the above materials in various proportions)	
Pigments	
White (Ti02)	ASTM D 476, Type III or IV
Yellow (CP Medium Chrome Yellow)	
Color	
White	Similar to Fed. 595-37778, except min. luminance (Y) shall be 55%
Yellow	Federal Highway Yellow Color Tolerance Chart
Glass Sphere Retention	
Max. % of beads showing entrapment by binder of less than 40% when 2 inch x 6 inch [50 mm x 152 mm] sample is bent over a 1/2 inch [13 mm] mandrel with the 2 inch [50 mm] dimension perpendicular to the mandrel axis and examined microscopically.	10
Tensile Strength and Elongation, Min.	
ASTM D 638 using 6 inch x 1 inch [152 mm x 25 mm]sample @ 70-80°, and a jaw speed @ break of 10-12 inches [254 mm - 305 mm] per minute.	T:150 psi [1 034 kPa]
Uppermost Surface Fracture Allowable	
Bend 6 inches x 12 inches [152 mm x 305 mm] sample over 1/2 inch [12.7 mm] diameter mandrel @ 80°F [27 °C] and visually examine.	None
Skid Resistance, Initial Min.	
ASTM E 303	45 BPN
Reflectance, Min.	
Photometric quantity shall be specific luminance (SL) expressed as millicandelas per square foot per footcandle @ 80 ° entrance angle and 0.2° and 0.5° observation angles as measured by Federal Testing Method Standard 370. Test distance shall be 50 feet [15 m] and sample size shall be 2 feet x 2 feet 6 inches [610 mm x 764 mm].	
Glass Spheres	
Index of refraction	1.5 - 1.6
Specific Gravity	2.4 - 2.55
Chemical Resistance - Immersion of 3 to 5 gram samples for 1 hour in 3N sulfuric acid and 50% sodium sulfide/water solution	

ITEM 537
RAISED PAVEMENT MARKERS

These specifications will describe the requirements for reflectorized and non-reflectorized traffic buttons, pavement markers and jiggle bars capable of being attached to a roadway surface by an adhesive.

MATERIALS

A. Design and Shape

Traffic buttons shall be round and done-shaped with a uniform curvature. The top and sides of the buttons shall be smooth and free from surface irregularities, pits, cracks, checks, chipping, discoloration and any other defects that adversely affect appearance and application. The buttons shall be made from ceramic materials and all buttons used on any one project shall be of the same manufacturer.

Jiggle Bar tiles shall be square in shape and having a required slant on the front of the tile. The slant on the back of the tile is optional. The jiggle bar shall be oriented with the front end towards traffic. The top and sides of the jiggle bars shall be smooth and free from surface irregularities, pits, cracks, checks, chipping, discoloration and any other defects that adversely affect appearance and application. The bottoms of the jiggle bar tiles may be of a rough texture and shall be free from gloss, glaze or any other substance that may reduce its bond to the adhesive. The jiggle bars shall be made from ceramic materials and all jiggle bars used on any one project shall be of the same manufacturer.

Pavement Markers shall be square in shape and with one or two reflectorized surfaces. The reflectorized surfaces shall be slanted from 25° minimum to 35° maximum. All markers supplied shall be of the same identical shape. The outer surface of the pavement Marker shall be smooth except for the molding or stamping of the manufacturer's imprint. All corners and edges exposed to traffic must be rounded. The interface between the reflective face(s) and the body of the marker shall be solid. The bottom surface of the Pavement Marker shall have a minimum roughness comparable to that of sandpaper, but shall not be of such roughness or grooved such that air will be intrapped when pressed into the adhesive.

The base of the raised pavement marker shall not deviate from a flat plane by more than 1/8 inch [3 mm].

Raised pavement markings shall consist of the following sizes and types:

Buttons:

width: 4 inch ± 1/8 inch [102 mm ± 3 mm]

height: 11/16 inch ± 1/8 inch [18 mm ± 3 mm]

Jiggle Bar: -

width: 6 inches ± 1/8 inch [25 mm ± 3 mm]

height: 1 inch ± 1/8 inch [25 mm ± 3 mm]

Pavement Marker:

width: 6 inches ± 1/8 inch [152 mm ± 3 mm]

height: 3/4 inch ± 1/8 inch [19 mm ± 3 mm]

B. Physical Requirements

Traffic Buttons and Jiggle Bar:
Water Absorption - The water absorption of the button and jiggle bar shall not exceed. 1.5 percent of the original dry weight when tested in accordance with ASTM C 373.

Autoclave Absorption - The glazed surface of the button and jiggle bar shall not craze, shall or peel when subject to one cycle of the Autoclave test at 250 psi [1.7 MPa]. (ASTM C-424).

Strength Requirements:

A random sample of 5 buttons shall be subjected to the compressive load test. The average compressive strength shall not be less than 1500 pounds [675 kilogram] and no individual button shall have a compressive strength less than 1200 pounds [540 kilogram] when tested in accordance with Test Method Test-434-A.

The compressive strength of the jiggle bar shall be determined on 1-inch [25 mm] diameter right cylinder test specimen cut through the center portion of tile by core drilling. Specimen ends shall be ground or lapped to form plane and parallel faces. The specimen faces shall be capped with a high strength capping compound to make them perpendicular to the axis of specimen. Specimen shall be loaded in accordance with Test Method Tex-418-A and shall exhibit a minimum compressive strength of 6000 psi [41 MPa].

Color:
The color of the buttons shall be as designated on the plans, shall be uniform and shall be determined by visual inspection in the field by the Engineer.

Glaze Thickness:
The glazed surface shall have a mean thickness not less than 0.005 inch [0.13 mm] when measured not closer than 1/4 inch [6 mm] from the edge of the button.

Pavement markers:

The pavement marker shall comply to the following tests:

Compressive strength: Unglazed 30,000 pounds/square inch [207 MPa].

Scratch hardness of glass: K value, Nicro-Character, Instrument 3400

Modulus of Rupture: Unglazed 10,500 pounds/square inch [72 MPa].

Water Absorption (%): 0 -0.05

Softening Temperature: Above 2500 °F [1371 °C].

MOHS Hardness (Glaze): 6.0 - 7.0

MOHS Hardness (Glaze): 7.0 - 8.0

C. Optical Requirements

The reflective device(s) shall be capable of providing reflection of amber, red or white light as required by the plans. The reflected light of each reflective face shall conform to the minimum reflective intensity requirements as shown in Table 1.

Table 1

SPECIFIC INTENSITY PER REFLECTIVE FACE AT 0.2 DEGREES OBSERVATION ANGLE

Horizontal Entrance Angle	Crystal	Amber	Red
4 degrees	3.00	2.00	0.40
20 degrees	1.50	1.00	0.20

Horizontal Entrance Angle is defined as the angle, in a plane parallel to the base of the maker, between a line in the base of the marker, between a line in the direction of the incident light and a line perpendicular to the leading edge of the reflective surface.

Observation angle is defined as the angle at the reflector between the observer's line of sight and the direction of the light incident on the traffic button.

Specific intensity is defined as the mean candlepower of the returned light at the specified observation and entrance angles for each foot-candle of incident light per reflective face.

Raised pavement markers shall be of the following reflective types as per Table 2.

Table 2

Traffic Buttons	W	Y	I-A	I-C	I-R	II A-A	II C-R
Jiggle Bar Tiles	W	Y	I-A	I-C		II A-A	II C-R
Pavement Markers			I-A	I-C	I-R	II A-A	II C-R

The following are descriptions for each type:

Type W shall have a white body and no reflective faces.

Type Y shall have a yellow body and no reflective faces.

Type I-A shall have a yellow body and the approach fac shall reflect amber light.

Type I-C shall have a white body and the approach face shall reflect white light.

Type I-R shall have a white body and the approach face shall reflect red light.

Type II A-A shall have a yellow body and two (2) reflective faces that reflect amber light.

Type II C-R shall have two (2) reflective faces, the approaching face shall reflect white light and the trailing fa shall reflect red light. The body, other than the reflective faces shall be white.

D. Epoxy Adhesive

1. The type of adhesive to be used on a specific project shall be designated by the Engineer based upon the setting time required under the prevailing weather and traffic conditions. The various types of adhesive are as follows:

Type I: Standard Setting Marked Adhesives.
Type I (M): Machine Epoxy
Type II: Rapid Setting Marked Adhesives (For use when a very fast set is required or if markers must be placed when pavement temperature is below 60 ° F [15 °C]).

2. Approximate set times at different temperatures for adhesive meeting the maximum set time allowed for each type are shown below:

Table 3

Pavement Temperature		**Approximate set time, Hours**	
°F	°C	Type I	Type II
115	44	1	0.4
95	35	2	0.5
77	25	4	0.7
60	16	8	0.9
50	10		1.5

3. For Types I and II, the ratio for the resin and hardener Lcomponents to be mixed together to form the finished adhesive shall be specified by the manufacturer and the components packaged in the proper proportions .

4. The mixed marker adhesive shall comply with the following physical requirements.

TABLE 4

PROPERTY	**REQUIREMENTS**
Thixotropy (Avg. thickness of cured material remaining on test panel), mils, Minimum	80
Adhesive Shear Strength, psi [MPa], Minimum	1800 [12.4 MPa]
Cleavage Strength, psi [MPa], Minimum	800 [5.5 MPa]
Water Gain, percent by Wt, Maximum	0.4
Impact Strength at 70-80 °F [21 °C -26 °C] ft. lbs [neutons/meter], Minimum	6 1/2 [95 N/m]
Ft. lbs, [neutons/meter], Minimum	6-1/2 [95 N/m]
Wet Strength, psi [MPa], Minimum	300 [2 MPa]

E. Testing:
The City of San Antonio reserves the right to perform any or all tests required by this item as a check on the tests reported by the manufacturer. Upon request, the Contractor shall furnish, free of charge, samples of the material of the size and in the amount determined by the Engineer for test purposes. In case of any variance, the City's tests will govern.

CONSTRUCTION METHODS:

The Contractor shall establish guides to mark the lateral location of pavement markings as shown on the plans or as directed by the Engineer. The Engineer shall approve locations of these markings and may authorize necessary adjustments from the plans.

The reflective faces of all Type II markers shall be positioned so that the direction of reflection of one (1) face shall be directly opposite to the direction of reflection of the other face.

Raised Pavement markers Type I-C shall have clear reflector face towards traffic. Raised pavement markers Type II C-R, shall have the clear face toward the normal traffic flow and the red face toward wrong-way traffic.

All raised pavement markers placed in broken lines shall be placed in line with and midway between the stripes. The first and last raised pavement marker in a no-passing line shall be a reflective marker. Buttons used to simulate a 10 feet [3 m] skip lane lines shall be spaced at 40 inches [1016 mm].

The pavement markers not placed in accordance with the plans or as directed by the Engineer shall be removed by the Contractor at the Contractor's expense.

The portion of the highway surface to which the raised pavement marker is attached by the adhesive shall be clean and free of dirt, grease, oil, and moisture at the time of installation. Surface preparation for installation of raised pavement markers will not be paid for directly, but shall be considered subsidiary to this item. Unsound pavement or other materials that would adversely affect the bond of the adhesive shall not be an acceptable surface.

The hot epoxy adhesive shall be applied so that 100 percent of the bonding area of the raised pavement marker will be in contact and shall be of sufficient thickness so that excess adhesive shall be forced out around the perimeter of the raised pavement marker. When the project is complete, the raised pavement marker shall be firmly bonded to the pavement; lines formed by the raised pavement markers shall be true, and the entire installation shall present a neat appearance.

Where required by the Engineer, pavement markings outside the limits of this project will be removed or adjusted to provide for a proper tie into this project. The old markings shall be removed or defaced in such a manner that they do not give the appearance of traffic pavement markings. The Engineer will approve all methods for removal or defacing of existing pavement markings.

MEASUREMENT:

Measurement will be based on the number of satisfactorily installed pavement markers.

PAYMENT:

Pavement markers will be paid for at the contract unit bid price per each type of marker. The price shall be full compensation for furnishing the raised pavement marker, epoxy adhesive and all other materials, surface preparation, installation, labor, equipment, tools and incidentals necessary to complete the work.

BID ITEMS:

Item 537.1: Traffic Button (Type W) per each

Item 537.2: Traffic Button (Type Y) per each

Item 537.3: Traffic Button (Type I-C) per each

Item 537.4: Traffic Button (Type I-R) per each

Item 537.5: Traffic Button (Type II A-A) per each

Item 537.6: Traffic Button (Type II C-R) per each

Item 537.7: Jiggle Bar (Type W) per each

Item 537.8: Jiggle Bar (Type W) per each

Item 537.9: Jiggle Bar (Type I-A) per each

Item 537.10: Jiggle Bar (Type I-C) per each

Item 537.11: Jiggle Bar (Type II A-A) per each

Item 537.12: Pavement Marker(Type I-A) per each

Item 537.13: Pavement Marker(Type I-C) per each

Item 537.14: Pavement Marker(Type I-R) per each

Item 537.15: Pavement Marker(Type II-A) per each

Item 537.16: Pavement Marker(Type II C-R) per each

ITEM 539
INTERSECTION GRADE PAVEMENT TAPE

The purpose of this specification is to describe a pavement tape specially formulated for use at intersections where excessive pavement wear and shoving tends to wear pavement markings prematurely. Tape is to be used for longitudinal or transverse lines, words, and symbol legends.

MATERIALS:

The preformed markings shall consist of white or yellow films with pigments selected and blended to conform to standard highway colors. Glass beads shall be incorporated to provide immediate and continuing retroreflection.

Preformed words and symbols shall conform to the applicable shapes and sizes as outlined in the sketch and the "Texas Manual on Uniform Traffic Control Devices" (current edition).

The preformed markings shall be capable of being adhered to asphalt cement concrete (ACC) or portland cement concrete (PCC) with liquid contact cement. Following proper application and tamping, the intersection markings are immediately ready for traffic. The contractor shall identify proper solvents, primers, and/or adhesives (where necessary) to be applied at the time of application, all equipment necessary for proper application, and any recommendations for application that will assure effective product performance.

The markings shall be highly durable retroreflective pliant polymer materials designed for use as symbols, legends and intersection markings, such as crosswalks and stop bars, in areas of high wear.

The retroreflective pavement marking film shall consist of a mixture of high quality polymeric materials, pigments and glass beads distributed throughout its base cross-sectional area, with a reflective layer of beads bonded to the top urethane wear surface. The edges of the preformed tape shall be clean cut and true.

The white and yellow films shall have the following initial minimum reflective values as measured in accordance with ASTM D 4061 (Table 1). The photometric quantity to be measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per foot-candle. The metric equivalent shall be expressed as millicandelas per square meter per lux. The test distance shall be 50 feet [15 m] and the sample size shall be a 24 inch x 30 inch [610 mm x 762 mm] rectangle.

Table 1:

	White				Yellow		
Entrance Angle (degrees)	86.0	86.0	86.5		86.0	86.0	86.5
Observation Angle (degrees)	0.2	0.5	1.0		0.2	0.5	1.0
Specific Luminance (sq meters per lux)	550	380	300		410	250	175

The surface of the retroreflective film shall provide an initial average skid resistance value of 45 BPN when tested in accordance with ASTM 303.

The pavement marking film shall be capable of use for patching worn areas of the same type of film in accordance with the manufacturer's instructions.

The film shall have a minimum tensile strength of 350 pounds per square inch [2413 kPa] of cross-section when measured in the direction of the length of roll and tested in accordance with ASTM D 638-76, except that a sample 6 inch x 1 inch [152 mm x 25 mm] shall be tested at a temperature between 70 °F and 80 °F [26 ° C - 26 °C] using a jaw speed of 10 to 12 inches [254 mm x 305 mm] per minute. The sample shall have a minimum elongation of 50% at break when tested by this method.

To have a good, effective performance life, the glass beads must be strongly bonded and not easily removed by traffic wear.

The following test shall be employed to measure reflectivity retention:

Taber Abraser Simulation Test
Using Taber Abraser with an H-18 wheel and a 125 gram load, the sample shall be inspected at 200 cycles, under a microscope, to observe the extent and type of bead failure.

No more than 15% of the beads shall be lost due to popout and the predominant mode of failure shall be "wear down" of the beads.

The size, quality and refractive index of the glass beds such be such that the performance requirements for the markings shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.

The film shall have glass bead retention qualities such that when a 2 inch x 6 inch [50 mm x 152 mm] is bent over a 1/2 inch [13 mm] diameter mandrel, with the 2 inch [50 mm] dimension perpendicular to the mandrel axis, microscopic examination of the area on the mandrel shall show no more than 10% of the beads with entrapment by the binder of less than 40%.

Item 539.9: Left White Arrow

Item 539.10: Comb. Thru/Rt. Arrow

The film, without adhesive, shall have a minimum thickness of 0.060 inch [1.5 mm].

The film, when applied according to the manufacturer's instructions, shall provide a neat, durable marking that will not flow or distort due to temperature if the pavement surface remains stable. The film shall be weather resistant and, through normal traffic wear, shall show no facing, lifting, or shrinkage which will significantly impair the intended usage of the marking throughout its useful life and shall show no significant tearing, roll back or other signs or poor adhesion.

The contractor shall be responsible for supplying and installing at no expense to the City replacement material for any markings which exhibit loss of adhesion or wear through to bare pavement due to traffic wear for a period of two years.

CONSTRUCTION METHODS:

The markings shall be applied and tamped in accordance with ITEM 536 “Preformed Plastic Pavement Markings” as described for Cold-Laid markings.

MEASUREMENT AND PAYMENT:

Measurement shall be made by the length of satisfactorily installed line, in feet [meters], the number and types of symbols and other pavement legends in accordance with the plans and specifications. The accepted quantities shall be paid at the contract unit price for the type of line or legend applicable in the bid list which shall be full compensation for materials, surface preparation, labor, and incidentals.

BID ITEMS:

Item 539.1: 4 inch [102 mm] Wide Yellow Line

Item 539.2: 4 inch [102 mm] Wide White Line

Item 539.3: 8 inch [204 mm] Wide Yellow Line

Item 539.4: 8 inch [204 mm] Wide White Line

Item 539.5: 12 inch [305 mm] Wide White Line

Item 539.6: 16 inch [406 mm] Wide White Line

Item 539.7: 24 inch [610 mm] Wide White Line

Item 539.8: Right White Arrow

Item 539.11: Comb. Thru/Lt. Arrow

Item 539.12: Word "ONLY"

Item 539.13: Straight White Arrow

Item 539.14: Complete Railroal Crossing Symbol, incl. two R's, crossbuck, and three tranverse bars.

Item 539.15: White Diamond

ITEM 540
TEMPORARY EROSION, SEDIMENTATION AND WATER POLLUTION PREVENTION AND CONTROL

This item shall govern the control measures necessary to prevent and control soil erosion, sedimentation and water pollution which may degrade receiving waters including rivers, streams, lakes, reservoirs, tidal water, groundwater and wetlands.

GENERAL:

The control measures contained herein shall be installed and maintained throughout the construction contract and coordinated with the permanent or existing temporary pollution control features specified elsewhere on the plans and in the specifications to assure effective and continuous water pollution control throughout the construction and post construction period. These control measures shall not be used as a substitute for the permanent pollution control measures unless otherwise directed by the Engineer in writing. The controls may include sediment control fences, inlet protection, baled hay, rock filter dams, dikes, swales, sediment traps and basins, pipe slope drains, paved flumes, construction exits, temporary seeding, sodding, mulching, soil retention blankets or other structural or non-structural water pollution controls. This item does not apply to commercial operations.

ITEMS OF WORK AND MATERIAL:

The items, estimated quantities and locations of the control measures are shown on the plans; however, the Engineer may increase or decrease the quantity of these items as the need arises. The materials will be shown on the plans and in the specifications. The Engineer may allow other materials and work as the need arises and as approved in writing. Pollution control measures may be applicable to contractor operations outside the right of way where such work is necessary as a result of roadway related construction such as construction and haul roads, field offices, equipment and supply areas, and materials sources.

PRECONSTRUCTION SUBMITTALS:

Operations on Right of Way:

Prior to the start of construction, the Contractor shall submit to the Engineer, for approval, schedules for accomplishment of the pollution control measures in accordance with the Storm Water Pollution Prevention Plan (SW3P). A plan for the disposal of waste materials generated on the project site must be submitted for approval, also. The Contractor shall submit to the Engineer, for approval, the proposed SW3P for the industrial activities (such as hot mix plants, concrete batch plants, or material handling areas) on the right of way.

Operations off Right of Way:

The Contractor shall provide the Engineer, for information purposes only, proposed methods of pollution control for Contractor operations in areas which are outside the right of way (such as construction and haul roads, field offices, equipment and supply areas, and material sources).

Pollution control measures for the Contractor's facilities off the right of way are not covered by the City's Environmental Protection Agency (EPA) NPDES general permit. The Contractor shall obtain his own Notice of Intent for the off-site operations. These pollution controls will not be measured for payment but shall be performed at the Contractor's expense.

CONSTRUCTION REQUIREMENTS:

The contractor shall provide control measures to prevent or minimize the impact to receiving waters as required by the plans and/or as directed by the Engineer in writing. Storm water discharges associated with industrial activities (such as hot mix plants, concrete batch plants or material handling areas) within the right of way must comply with the terms of the EPA'S NPDES general permit.

Inactive construction areas are defined as areas in which no construction activity will occur for a period of 30 days or longer. Inactive construction areas which have been disturbed will require stabilization through the use of vegetation, mulch, erosion control matting or structural methods within 7 calendar days from the last construction activity in the area. At all times prior to stabilization, inactive construction areas shall be considered as active, disturbed construction area, contributing to the sediment loading at the site control systems. After stabilization, inactive construction areas

will be considered undisturbed areas, eliminating the contribution of sediment to the erosion control devices.

The Contractor shall effectively prevent and control erosion and sedimentation on the site at the earliest practicable time as outlined in the approved schedule. Control measures, where applicable, will be implemented prior to the commencement of each construction operation or immediately after the area has been disturbed.

The Contractor shall limit the amount of disturbed earth to the area(s) shown on the plans or as directed by the Engineer. The Engineer has the authority to limit the disturbed surface area exposed by construction operations. If, in the opinion of the Engineer, the Contractor is not able to effectively control soil erosion and sedimentation resulting from construction operations, the engineer will limit the amount of disturbed area to that which the Contractor is able to control.

Should the control measures fail to function effectively, the Contractor shall act immediately to bring the erosion and sedimentation under control by maintaining existing controls or by providing additional controls as directed by the Engineer. When in the opinion of the Engineer, the site is adequately stabilized, the control measures, excepting mulches and soil retention blankets, will be removed and properly disposed of by the Contractor. Soil retention blankets shall be removed only when, in the opinion of the Engineer, final permanent perennial seeding would be adversely affected by the presence of an existing solid retention blanket.

All erosion, sediment and water pollution controls will be maintained in good working order. A rain gauge shall be provided by the Contractor and located at the project site. Within 24 hours of a rainfall event of 0.5 inch [13 mm] or more as measured by the project rain gauge, the Contractor and Inspector will inspect the entire project to determine the condition of the control measures. Sediment will be removed and devices repaired as soon as practicable but no later than 7 days after the surrounding exposed ground has dried sufficiently to prevent further damage from equipment needed for repair of control measures.

In the event of continuous rainfall over a 24-hour period, or other circumstances that preclude equipment operation in the area, the Contractor will hand carry and install additional backup devices as determined by the Engineer. The Contractor will remove silt accumulations and deposit the spoils in an area approved by the Engineer as soon as practical. Any corrective action needed for the control measures will be accomplished in the sequence directed by the Engineer; however, areas adjacent to waterbodies shall generally have priority followed by devices protecting storm sewer inlets.

CONTRACTOR RESPONSIBILITIES:

The contractor shall also conform to the following practices and controls. All labor, tools, equipment and incidentals to complete the following work will not be paid for directly, but shall be considered as subsidiary work to the various items included in the contract, unless otherwise noted.

1. Disposal areas, stockpiles and haul roads shall be constructed in a manner that will minimize and control the amount of sediment that may enter receiving waters. Disposal areas shall not be located in any wetland, waterbody or streambed. Construction roads may not be located in or across any waterbody or streambed without prior approval of the Engineer and shall be done in compliance with applicable rules and regulations.

2. Construction operations in rivers, streams, lakes, tidal water wetlands and other waterbodies shall be restricted to those areas where it is necessary to perform the work shown on the plans. Wherever streams are crossed, temporary bridges, timber mats or other structures shall be used.

3. Protected storage for paints, chemicals, solvents, fertilizers and other potentially toxic materials will be provided by the Contractor at a location approved by the Engineer.

4. Construction staging areas and vehicle maintenance areas shall be constructed by the Contractor in a manner to minimize the runoff of pollutants. Those areas located on the right of way must be approved by the Engineer. The Contractor shall prevent pollution of receiving waters with petroleum products or other hazardous or regulated substances. When work areas or material sources are located adjacent to a waterbody, control measures shall be used to keep sediment and other contaminants from entering the adjacent waterbody. Control devices located on the right of way will be measured for payment. Care shall be taken during the construction and removal of control measures to minimize down-gradient sedimentation.

5. All waterways shall be cleared as soon as practicable of temporary embankment, temporary bridges, matting, false work, piling, debris or other obstructions placed during construction operations that are not a part of the finished work.

6. Disturbance of vegetation shall be minimized and limited to only what is shown on the construction plans or as directed by the Engineer in writing.

7. The Contractor shall clean paved surfaces as necessary to remove sediment which has accumulated on the roadway.

PROJECT ACCEPTANCE:

The project will not be accepted until the Contractor provides a uniform perennial vegetative cover with a density of 70% of adjacent undisturbed areas, or, if in the opinion of the Engineer, permanent measures (such as rip-rap, gabions, or geotextiles), supplemented by temporary measures (such as mulching with seed, hay bales, sediment control fences, earth dams, etc.) have been employed that will control erosion, sedimentation and water pollution until sufficient vegetative cover can be established.

MEASUREMENT:

If the Contractor is required to install temporary erosion, sediment and water pollution control measures due to his negligence, carelessness, lack of maintenance, or failure to install permanent controls as a part of the work as scheduled, and measures are ordered in writing by the Engineer, such work shall not be measured for payment, but shall be performed at the Contractor's expense.

When the need for control measures can not be attributed to the contractor's negligence, carelessness, lack of maintenance or failure to install permanent water pollution control measures and these measures are shown on the plans and/or directed by the Engineer, these measures shall be measured and paid for in accordance with applicable contract bid items.

In case of failure on the part of the Contractor to prevent and control soil erosion, sedimentation and water pollution which may degrade receiving water, the Engineer reserves the right to employ outside assistance or to use City forces to provide the necessary corrective measures. All costs including engineering costs will be deducted from any moneys due or to become due to the Contractor.

PAYMENT:

All labor, tools, equipment and incidentals to complete the work specified under "Contractor Responsibilities" will not be paid for directly, but will be considered subsidiary to the various bid items, unless otherwise noted.

Pollution control measures outside the right of way will not be measured for payment but shall be performed at the Contractor's expense.

Control measures as shown on the plans will be paid for in accordance with applicable contract bid items.

ITEM 541
CURB INLET GRAVEL FILTER

This item shall govern the installation of temporary "Curb Inlet Gravel Filter(s)", in the locations shown on the plans and as required by these specifications during the construction period to prevent sediment from erosion of the construction area from being carried from the construction area into drainage inlets by rainwater runoff.

MATERIALS:

Gravel Filter Bags: Polypropylene, polyethylene, or polyamide woven fabric, minimum weight 4 ounces per square yard [113 grams per square meter], Mullen burst strength exceeding 300 psi [2 MPa] and ultraviolet stability exceeding 70 percent. Length shall be approximately 24 inches [610 mm], width shall be 16 to 18 inches [406 -457 mm] and the thickness shall be 6 inches [152 mm]. Gravel bags shall be filled with 3/4 inch [19 mm] gravel.

Concrete Masonry Units: Hollow, Non-Load-Bearing Concrete blocks of 1500-2000 psi [10 MPa - 14 MPa], 28 day compressive strength concrete shall be used with the following dimensions: 8"x6"x16" [200 x150 x 400 mm] width, height, and length, respectively.

Wood Blocks: Wolmanized treated 2"x4" [50x100 mm] lumber, length as per inlet size.

CONSTRUCTION METHODS:

Install the curb inlet gravel filters in the following manner.

1. Place the 2"x4" [50x100 mm] treated lumber in front of and parallel with the opening of the inlet.

2. Place the Concrete Masonry Units (CMUs) around the inlet, to be protected, in front of the 2"x4" [50x100 mm] lumber, with the openings of the CMUs facing the inlet.

3. Surround the CMUs with gravel bags, making certain that there are no gaps are evident between the gravel bags.

MAINTENANCE:

The gravel filter bags shall be maintained in good condition by the Contractor. All necessary work and materials to maintain the integrity of the bags, including keeping fabric free of accumulated silt, debris, etc., shall be provided until earthwork construction and permanent erosion control features are in place and/or the disturbed area has been adequately stabilized as per Item 540 "Temporary Erosion, Sedimentation and Water Pollution Prevention and Control". The areas damaged by the removal process shall be stabilized by the contractor using appropriate methods as approved by the Engineer.

Torn or punctured bags shall be replaced with a new Filter bag.

When the accumulated sediment deposit reaches a depth of approximately 6 inches [152 mm], it shall be removed and disposed of at approved sites in a manner that will not contribute to additional siltation. If the structure ceases to function as intended, the Engineer may direct that the Filter bag be replaced. Such replacement will not be measured for payment.

MEASUREMENT:

Measurement shall be made by the linear foot [meter], as measured on the centerline of the gravel bags installed, complete, in place, and ready for use including all components necessary for a completed and working installation.

PAYMENT:

The work performed and the materials furnished as specified herein, measured as provided above shall be paid for at the unit price bid per linear foot [meter] for "Curb Inlet Gravel Filter, which payment shall be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work as specified, including maintaining and replacing the gravel bags as required by these specifications, removal of accumulated silt, and removal and proper disposal of the "Curb Inlet Gravel Filter" upon completion of site stabilization.

BID ITEM:

Item 541: Curb Inlet Gravel Filters - per linear foot [meter].

ITEM 542
TEMPORARY SEDIMENT CONTROL FENCE (SILT FENCE)

This item shall govern for the materials to be furnished and for the installation, maintenance and removal of temporary sediment control fence of the dimensions shown on the plans. This item will be used temporarily during construction to control erosion and sedimentation.

MATERIALS:

1. **Fence Description.** The fence shall be a net-reinforced fence, using woven geotextile fabric.

2. **Fabric**. Fabric may be manufactured from polyester, polypropylene or polyamide and shall be resistant to ultraviolet degradation, mildew and rot and shall be suitable for use in a wet soil and stagnant water environment. The edge of woven fabric shall be sealed or selveged to prevent raveling. Fabric shall be at least 36 inches [1 m] wide with 6 to 8 inches [152 mm - 203 mm] inches of the width buried in a trench to prevent undercutting, unless specified otherwise on the plans. The fabric shall exhibit the following physical properties when sampled and tested using the specified methods shown in Table 1.

3. **Posts**. Posts shall be a minimum of 48 inches [1.2 m] long, essentially straight, and shall be wood or steel, unless otherwise shown on the plans. Soft wood posts shall be at least 3 inches [76 mm] in diameter or nominal 2x4 inches [50 mm x100 mm]. Hardwood posts shall have a minimum cross section of 1.5 x 1.5 inches [38 mm x 38 mm]. Steel posts shall be "T" or "L" shaped with a minimum weight of 1.3 pounds per linear foot [6.3 kg per meter].

4. **Net Reinforcement**. Net reinforcement shall be galvanized welded wire mesh of a minimum 12.5 gauge wire or equal as approved by the Engineer with a maximum opening size of 2 inches [50 mm] by 4 inches [102 mm] and shall be at least 24 inches [610 mm] wide unless otherwise shown on the plans.

5. **Staples**. Staples used to secure reinforcement and fabric to wood posts shall have a crown at least 3/4 inch [19 mm] wide and legs 1/2 inch [13 mm] long.

6. **Used Materials**. Previously-used materials, meeting the above requirements and when approved by the Engineer, may be used.

CONSTRUCTION METHODS.

The temporary sediment control fence shall be used during construction near the downstream perimeter of a disturbed area to intercept sediment from sheet flow. The fence may be incorporated into the erosion control measures used to control sediment in areas of higher flow. The fence installation methods shall be as specified below, unless otherwise shown on the plans. The physical alignment and location of the fence shall be as shown on the plans or as directed by the Engineer.

1. **Installation of Post**. Posts shall be embedded 18 inches [457 mm] deep, or adequately anchored if in rock, with a spacing of 6 to 8 feet [2 m -2.4 m], and installed on a slight angle toward the anticipated run-off source.

2. **Fabric Anchoring.** Trenches shall be dug along the uphill side of the fence to anchor 6 to 8 inches [152 mm - 203 mm] of fabric. The trench shall have a minimum cross section of 6 x 6 inches [150 mm x 150 mm]. The fabric shall be installed in the trench such that 4 to 6 inches [102 mm - 152 mm] of fabric is against the side of the trench and approximately 2 inches [50 mm] of fabric is across the bottom in the upstream direction. The trench shall then be backfilled and hand tamped as approved by the Engineer.

3. **Fabric Attachment** The reinforcement shall be attached to the end posts, if wood, by staples, or if steel, by T-clips or sewn vertical pickets at a minimum of 4 locations. The reinforcement shall be attached to each succeeding post as approved by the Engineer. The ends of successive reinforcement sheets or rolls shall be connected at a fence post at least 6 times with hog rings.

The fabric shall be fastened to the top strand of reinforcement by hog rings or cord at a maximum spacing of 15 inches [381 mm].

4. **Fabric Splices**. Splices shall occur at a fence post and shall have a minimum lap of 6 inches (152 mm) attached in at least six places. Splices in concentrated flow areas will not be permitted.

MAINTENANCE:

The temporary sediment control fence shall be maintained in good condition (including staking, anchoring, tension adjustments, etc.) by the Contractor. All necessary work and materials to maintain the integrity of the fence, including keeping fabric free of accumulated silt, debris, etc., shall be provided until earthwork construction and permanent erosion control features are in place and/or the disturbed area has been adequately stabilized as per Item 540 "Temporary Erosion, Sedimentation and Water Pollution Prevention and Control". The areas damaged by the removal process shall be stabilized by the Contractor using appropriate methods as approved by the Engineer.

Torn or punctured fabric shall be repaired by the placement of a patch consisting of an additional layer of fabric over the damaged area. The patch shall have a minimum overlap of 18 inches [457 mm] in all directions and be securely attached to the repaired fabric.

When the accumulated sediment deposit reaches a depth of approximately 6 inches [152 mm], it shall be removed and disposed of at approved sites in a manner that will not contribute to additional siltation. If the structure ceases to function as intended, the engineer may direct that the fence or portions thereof be replaced. Such replacement will not be measured for payment.

MEASUREMENT:

Measurement shall be made by the linear foot [meter], as measured on the centerline of the fence installed, complete, in place and ready for use including all components necessary for a completed and working installation.

PAYMENT:

The work performed and materials furnished as prescribed by this Item will be paid for at the unit price bid per linear foot [meter] for "Temporary Sediment Control Fence", which price shall be full compensation for furnishing, placing, removing and maintenance of the fence; for all required trenching, fence posts, fabric, backfill and removal of accumulated sediment deposits, as described under "Maintenance" and for all labor, tools, equipment and incidentals necessary to complete the work.

BID ITEM:

Item 542: Temporary Sediment Control Fence (Silt Fence) - per linear foot [meter].

Table 1

Physical Property	Test Method	Min. Req.
(1) TensileStrength, 1b	ASTM D 4632	90 MIN
(2) Elongation @ Yield, %	ASTM D 4632	100 MIN
(3) Trapezoidal Tear, 1b	ASTM D 4533	35 MIN
(4) Apparent Opening Size	ASTM D 4751	50-80
(5) Permittivity, 1/sec	ASTM D 4491	1.0 MIN
(6) Ultraviolet Stability original tensile strength retained after 500 hrs. exposure, %	ASTM D 4355	80 MIN

ITEM 543
CONSTRUCTION EXIT

This item shall govern for the materials to be furnished and for the installation, maintenance, and removal of construction exits of the type and dimensions shown on the plans.

GENERAL:
This item will be used temporarily during construction to control the tracking of sediment, mud, gravel, etc., from a construction site or other areas identified by the Engineer to a public right of way, street, sidewalk or parking area.

MATERIALS:
All materials shall meet the applicable requirements as indicated below for the specified type of construction exit.

1. **Rock Construction Exit.** Rock used for long- and short-term construction exits shall consist of crushed stone. The aggregates shall be clean, hard, durable materials free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic and injurious matter.

2. **Timber Construction Exit.** Timber for long-term construction exits shall consist of treated railroad ties and timbers. The railroad ties and timbers shall be treated to control rot and shall be No. 2 quality or better and free of large and loose knots. Timber shall be fastened with nuts and bolts or lag bolts all of which shall meet or exceed ASTM - A307.

Timber for short-term construction exits shall be treated to control rot and shall be No. 2 quality or better and free of large and loose knots. Plywood and/or pressed wafer board shall be a minimum of 1/2 inch [13 mm] thick.

3. **Foundation Course**. The foundation course shall be flexible base, bituminous concrete, portland cement concrete or other materials as approved by the Engineer.

CONSTRUCTION METHODS:
When tracking conditions exist, traffic shall not be allowed to cross or leave the construction site and move directly onto a public roadway, alley, sidewalk, parking area, or other right of way in areas other than at locations of construction exits. Construction exits can be either for long or short term use. Foundation courses, if needed, shall be used with the long-term construction exits.

1. **Long-Term Construction Exit.** The exit shall be placed over a foundation course, if needed. The foundation course and/or compacted subgrade shall be properly graded to direct runoff from the construction exit to a sediment trap as shown on the plans or as direcrted by the Engineer. The exit shall normally be constructed a minimum length of 50 feet [15 m]. The width shall be at least 14 feet [4.3 m] for one-way traffic and 20 feet [6 m] for two-way traffic but shall not be less than full width of all points of ingress and egress and shall be sufficient for all ingress and egress.

(a) Type 1 ConstructionExit. This exit shall consist of open-graded crushed stone with a size of 4 - 8 inches [102 mm- 203 mm] as shown on the plans. The depth of the aggregate shall not be less than 8 inches [203 mm].

(b) Type 2 Construction Exit. This exit shall be constructed of treated railroad ties and timbers as shown on the plans.

2. **Short-Term Construction Exit.**

(a) Type 3 Construction Exit. This exit shall be either open-graded crushed stone with a size of 2 or 4 inches [50 mm - 102 mm], or plywood or wafer board. This exit shall be used for daily operations when tracking conditions exist such as traffic crossing the construction site at locations where long-term exits are not practicable.

(b) Type 4 Construction Exit. This exit shall be as shown on the plans.

MAINTENANCE:
Exits shall be maintained in a condition which will prevent tracking or flowing of sediment onto public right of way. This may require periodic removal and replacement of stone or timber, or other material as conditions demand and repair and/or clean out of any measures used to trap sediment. Sediment spilled, dropped, washed or tracked onto public right of way shall be immediately removed by the Contractor and disposed of at an approved site and in a manner that will not contribute to additional siltation.

When necessary, wheels shall be cleaned to remove sediment prior to entrance onto public right of way.

When necessary or when directed by the engineer, the construction exits may be removed and/or replaced as many times as needed.

The construction exits shall be removed promptly when directed by the Engineer. Discarded materials shall become the property of the Contractor for his disposal at an approved site. The area beneath the construction exit and any area damaged by the removal process shall then be stabilized by the Contractor using appropriate methods as approved by the Engineer. Stabilization shall be as defined by Item 540, "Temporary Erosion, Sedimentation and Water Pollution Prevention and Control".

MEASUREMENT:

Construction exits will be measured by the square yard [square meter] of surface area of completed, accepted and maintained work.

PAYMENT:

The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement", will be paid for at the unit price bid for "Construction Exits", of the type specified, which price shall be full compensation for securing and furnishing all materials, including all royalty and freight involved; for loosening, blasting, excavating, screening, crushing when required; for loading all materials; for hauling and delivering to the construction site; for spreading, mixing, blading, dragging, shaping and finishing; cleaning of wheels, when necessary; maintenance (including removing and replacing when necessary or when directed by the Engineer); and for all manipulations, labor, tools and incidentals necessary to complete the work.

Construction of sediment traps as well as the periodic removal of accumulated sediment deposits (as described under "Maintenance") used in conjunction with the construction exit will not be measured and paid for, but are considered subsidiary to this item.

BID ITEM:

Item 543 - Construction Exit - per square yard [square meter].

ITEM 544
ROCK FILTER DAMS FOR EROSION AND SEDIMENTATION CONTROL

This item shall govern for the materials to be furnished and for the installation, maintenance and removal of rock filter dams of the dimensions shown on the plans. The rock filter dams shall be constructed at the locations shown on the plans and as directed by the Engineer.

MATERIALS:

Unless otherwise specified, all aggregate used for the construction of the rock filter dams shall be hard, durable, clean, open-graded, and shall naturally resist crumbling, flaking and eroding. Aggregate gradation shall be 3 to 6 inches [76 mm - 152 mm] for rock filter dams Types 1, 2 and 4 and shall be 4 to 8 inches [102 mm - 203 mm] for Type 3.

The galvanized steel wire mesh and tie wires for Types 2 and 3 shall be a minimum 20 gauge unless specified on the plans.

For type 4: steel wire mesh shall utilize a double twisted hexagonal weave; mesh opening shall be a nominal 2.50 x 3.25 inch [64 mm - 83 mm], steel wire for netting shall be 0.0866 inch [2 mm] (U.S. Gauge No. 13) minimum; steel wire for selvedges and corners shall be 0.1063 inch [3 mm] (U.S. Gauge No.11) minimum: and binding or tie wire shall be 0.0866 inch [2 mm] (U.S. Gauge No. 13) minimum.

Unless otherwise specified, the sandbag material shall be made of polypropylene, polyethylene or polyamide woven fabric, minimum unit weight 4 ounces per square yard [113 grams per square meter], Mullen burst strength exceeding 300 psi [2 KPa] and ultraviolet stability exceeding 70 percent. The sandbag size shall be 24 to 30 inches [610 mm - 762 mm] in length, 16 to 18 inches [406 mm- 457 mm] in width, 6 to 8 inches [152 mm - 203 mm] thick and weigh 90 to 125 pounds [41- 56 kilograms]. The sand shall be coarse grade.

CONSTRUCTION METHOD:

Trees, brush, stumps and other objectionable material shall be removed and disposed of as per Item 101, "Preparing Right of Way" so as not to interfere with the construction of the filter dams.

The filter dams shall be constructed according to the following criteria unless otherwise shown on the plans.

1. Type 1 (non-reinforced
Height - 18 inches [457 mm] minimum, measured vertically from existing ground to top of filter dam.
Top Width - 2 feet minimum [610 mm].
Slopes - 2:1 maximum

2. Type 2 (reinforced).
Height - 18 inches [457 mm] minimum, measured vertically from existing ground to top of filter dam.
Top Width - 2 feet [610 mm] minimum
Slopes - 2:1 maximum

The aggregate shall be placed on the galvanized wire mesh to the lines, height and slopes specified without resulting in undue voids, and to the satisfaction of the Engineer. The mesh shall be folded at the upstream side over the aggregate and secured to itself on the downstream side. The mesh shall be attached to itself with wire ties, hog rings, or as directed by the Engineer.

3. Type 3 (reinforced).
Height - 36 inches [1 m] minimum, measured vertically from existing ground to top of filter dam.
Top Width - 2 feet [610 mm] minimum.
Slopes - 2:1 maximum.

The aggregate shall be placed on the galvanized wire mesh to the lines, height and slopes specified without resulting in undue voids, and to the satisfaction of the Engineer. The mesh shall be folded at the upstream side over the aggregate and secured to itself on the downstream side. The mesh shall be attached to itself with wire ties, hog rings, or as directed by the Engineer.

4. Type 4 (Sack Gabions).
Sack gabions are supplied folded flat, packed in bundles. Single sacks shall be removed from the bundle, unfolded flat on the ground, and all kinks and bends stepped out.
For vertical filling, the two sides edge wires are connected by using the lacing wire in a "single loop - double loop" pattern on a 4 to 5 inch [102 mm - 127 mm] spacing. At one end, the "end lacing rod" must be pulled tight, wrapped around the end and twisted 4 times. At the filling end, the rod shall be pulled tight, cut leaving about 6 inch [152 mm] length and twisted 4 times.

For horizontal filling, the sack shall be placed flat in a filling trough, filled with stone and then sides and end connected and secured as described above.

Lifting and placing shall be accomplished by placing a No. 6 rebar (or equal) 5 feet [1.5 m] long in the mesh, perpendicular to the longitudinal axis and close to the knot of one end. Lifting should be made from the central point. Sack gabions shall conform to existing contours.

5. Type 5.
Type 5 as shown on the plans.

MAINTENANCE:

The area upstream from the filter dams shall be maintained in a condition which will allow sediment to be removed following the runoff of a rainfall event. When the silt reaches a depth equal to 1/3 the height of the dam or 1 foot [305 mm], whichever is less. The Contractor shall remove the accumulated sediment and dispose of it at an approved site in a manner that will not contribute to additional siltation. The filter dams shall be reshaped as needed and as directed by the Engineer.

The filter dams shall be maintained in place until all upstream areas are adequately stabilized as per Item 540 "Temporary Erosion, Sedimentation and Water Pollution Prevention and Control". The area beneath the filter dams and area damaged by the removal process shall then be stabilized by the contractor using appropriate methods as approved by the Engineer.

MEASUREMENT:

This item will be measured by the linear foot [meter] of filter dam, complete in place and ready for use including all components necessary for a complete and working installation.

PAYMENT:

The work performed and material furnished as prescribed by this item, will be paid for at the unit price bid for "Rock Filter Dams", of the type specified, which price shall be full compensation for furnishing, placing, removing, maintenance of the filter dam; for all required trenching, backfill and removal of accumulated sediment deposits, as described under "Maintenance" and for all labor, tools, equipment and incidenalts necessary to complete the work.

Stabilization as described under maintenance will be measured and paid for under the applicable bid items.

BID ITEMS:

Item 544.1: Rock Filter Dams (Type 1) - per linear foot [meter].

Item 544.2: Rock Filter Dams (Type 2) - per linear foot [meter].

Item 544.3: Rock Filter Dams (Type 3) - per linear foot [meter].

Item 544.4: Rock Filter Dams (Type 4) - per linear foot [meter].

Item 544.5: Rock Filter Dams (Type 5) - per linear foot [meter].

ITEM 545
⁂
BALED HAY FOR EROSION AND SEDIMENTATION CONTROL

This item shall govern for the installation, maintenance, and removal of baled hay utilized temporarily during construction to control erosion and sedimentation.

MATERIALS:
The hay baled shall weigh a minimum of 50 pounds [23 kg], be composed entirely of vegetable matter, and measure at least 30 inches [762 mm] in length. They shall be bound by wire, nylon or polypropylene string.

CONSTRUCTION METHODS:
The hay bales shall be installed in accordance with the details and at the locations shown on the plans by embedding in the soil a minimum of 4 inches [102 mm], and where possible, approximately one half the height of the bale, or as directed by the Inspector. Gaps between bales shall be filled with hay.

MAINTENANCE:
The baled hay installation shall be maintained in good condition by the Contractor. All necessary work and materials to maintain the integrity of the installation shall be provided until permanent erosion-control features are in place and/or the disturbed area has been adequately stabilized, as per Item 540 "Temporary Erosion, Sedimentation and Water Pollution Prevention and Control". The area beneath the baled hay and area damaged by the removal process shall then be stabilized by the Contractor using appropriate methods as approved by the Inspector.

When the accumulated sediment reaches a depth of approximately 6 inches [152 mm], it shall be removed and deposited at approved sites in a manner that will not contribute to additional siltation. If the installation ceases to function as intended due to washouts, etc., the Inspector may direct that the installation or portions thereof be replaced. Such replacement will not be measured for payment.

MEASUREMENT:
This item will be measured by the linear foot [meter] of bale, complete in place and ready for use including all components necessary for a complete and working installation.

PAYMENT:
The work performed and materials furnished as prescribed by this item will be paid for at the unit price bid for "Baled Hay for Erosion and Sedimentation Control", which price shall be full compensation for furnishing, placing, removing, maintenance of the bales, removing and replacing when necessary; for all required trenching, backfill and removal of accumulated sediment deposits as described under "Maintenance" and for all labor, tools, equipment and incidentals necessary to complete the work. Payment shall also include site stabilization after removal of the hay bales.

BID ITEM:
Item 545: Baled Hay for Erosion and Sedimentation Control - per linear foot [meter].

ITEM 546
GRAVEL FILTER BAG(S)

This item shall govern the installation of temporary "Gravel Filter Bag(s)", in the locations shown on the plans and as required by these specifications, during the construction period to prevent sediment from erosion of the construction area from being carried from the construction area by rainwater runoff.

MATERIALS:
Gravel Filter Bags: Polypropylene, polyethylene, or polyamide woven fabric, minimum unit weight 4 ounces per square yard [113 grams per square meter], Mullen burst strength exceeding 300 psi [2 MPa] and ultraviolet stability exceeding 70 percent. Length approximately 24 inches [610 mm], width 16 to 18 inches [406 -457 mm] and thickness 6 inches [152 mm]. Fill gravel bags with 3/4 inch [19 mm] gravel.

CONSTRUCTION METHODS:
Install the gravel filter bag sets in the following manner:

1. Gravel filter bags should be installed at an angle which is perpendicular to the flowline of the curb and gutter. The gravel filter bags are to be installed extending from the curb toward the centerline of the street, to a maximum distance of 4 feet [1.2 m] from the curb line. Place gravel filter bags such that there are no apparent opening between bags.

2. If necessary, as determined by the Inspector, position additional gravel filter bag(s) sets downstream, or upstream, from the initial set of gravel filter bag(s). If possible position successive sets such that the lowest ground elevation of the upstream set is approximately level with the top of the downstream set.

MAINTENANCE:
The gravel filter bags shall be maintained in good condition by the Contractor. All necessary work and materials to maintain the integrity of the bags, including keeping fabric free of accumulated silt, debris, etc., shall be provided until earthwork construction and permanent erosion control features are in place and/or the disturbed area has been adequately stabilized, as per Item 540 "Temporary Erosion, Sedimentation and Water Polution Prevention and Control". The areas damaged by the removal process shall be stabilized by the contractor using appropriate methods as approved by the Engineer.

Torn or punctured bags shall be replaced with a new bag.

When the accumulated sediment deposit reaches a depth of approximately 6 inches [152 mm], it shall be removed and disposed of at approved sites in a manner that will not contribute to additional siltation. If the structure ceases to function as intended, the Engineer may direct that the Filter bag be replaced. Such replacement will not be measured for payment.

MEASUREMENT:
Measurement shall be made by the linear foot [meter] measured on the centerline of the gravel bags installed, complete, in place, and ready for use including all components necessary for a completed and working installation.

PAYMENT:
The work performed and the materials furnished as specified herein, shall be paid for at the unit bid per linear foot (meter) for "Gravel Filter Bag(s)", which payment shall be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work as specified, including maintaining and replacing the bags as required by these specifications, removal of accumulated silt, and removal and proper disposal of the "Gravel Filter Bag(s)" upon completion of site stabilization.

BID ITEM:
Item 546: Gravel Filter Bag(s) - per linear foot [meter].

ITEM 550
TRENCH EXCAVATION SAFETY PROTECTION

This item shall govern for the Trench Excavation Safety Protection required for the construction of all trench excavation protection systems to be utilized in the project and including all additional excavation and backfill necessitated by the protection system.

CONSTRUCTION METHODS:

Trench Excavation Safety Protection shall be accomplished as required by the most recent provisions of, Part 1926, Subpart P - Excavations, Trenching, and Shoring of the Occupational Safety and Health Administration (OSHA) Standards and Interpretations, as may be amended.

MEASUREMENT:

Trench Excavation Safety Protection shall be measured by the linear foot[meter] along the centerline of any OSHA defined trench that may be entered by personnel, and is not greater than 15 feet [4.5 m] wide, including manholes and other structures.

PAYMENT:

Payment for Trench Safety Excavation Protection, measured as prescribed above shall be made at the unit price bid per linear foot [meter] of Trench Excavation Safety Protection regardless of the depth of the trench.

Payment shall include all components of the Trench Excavation Safety Protection System which can include, but not be limited to sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or temporary diversion and proper recapture and transportation of water to provide adequate drainage. Payment shall also include the additional excavation and backfill required, any jacking, jack removal, and removal of the trench supports after completion.

Payment of all work prescribed under this item shall be full compensation for all additional excavation and backfill associated with the item; for any retention by contractor of structural design/geotechnical/safety/ equipment consultant; for furnishing, placing and removing all shoring, sheeting, or bracing; for dewatering or temporary diversion and proper recapture and transportation of water; for all jacking and jack removal; and for all other labor, material, tools, equipment and incidentals necessary to complete this portion of the work.

BID ITEM:

Item 550 - Trench Excavation Safety Protection - per linear foot [meter].

ITEM 551
SPECIAL SHORING

This item shall govern for the Special Shoring required for securing and maintaining certain designated areas of the excavation construction limits in a vertical line and including all additional work necessary for supporting weight loads created by the traveling public adjacent to said areas.

CONSTRUCTION METHODS:

All Special Shoring shall generally conform to the established alignment and cross sections or other limits for certain designated areas of the excavation indicated in the plans. Suitable construction techniques and materials for shoring shall be implemented in accordance with OSHA regulations to maintain the existing soil in a vertical and stable condition outside the construction limits. The existing surface treatment and soil outside of the construction limits will, in conjunction with the implementation of Special Shoring materials and construction techniques, be supporting concrete traffic control barriers conforming to the Texas Manual on Uniform Traffic Control Devices and vehicular traffic.

MEASUREMENT:

Special Shoring shall be measured by the square foot [square meter] along the horizontal ground line adjacent to the Special Shoring, to the bottom of the trench. Special Shoring shall remain the property of the contractor and shall be removed after usage.

PAYMENT:

Payment for Special Shoring, measured as prescribed above, shall be made at the unit price bid per square foot [square meter] of Special Shoring used, which price shall be full compensation for all work herein specified, including the furnishing of all structural design/geotechnical/equipment consultant services, materials, equipment, tools, labor, and incidentals necessary to complete and remove the Special Shoring work. In the event that Special Shoring is specified in the area of a "trench" excavation as defined in Part 1926, Subpart P - Excavations, Trench, and Shoring of OSHA, recovery of safety related costs shall be only under contractor's bid for Item 700, Trench Excavation Safety Protection.

BID ITEM.

Item 551 - Special Shoring - per square foot [square meter].

DIVISION VI
TRAFFIC SIGNALS

632 Electrical Service

634 Detector Loops

636 Street Light Fixtures

ITEM 600
TRAFFIC SIGNAL GENERAL CONDITIONS

The purpose of this specification is to describe the necessary definitions, regulations, procedures, work zone control, and maintenance for traffic signal construction for the City of San Antonio. These specifications pertain to all phases of construction and modifications of new and/or existing traffic signals as shown on the project plans. This specification will be enforced on all contracts which include signalized intersections, even if no traffic signal work is part of the Contract.

DEFINITIONS:

The words defined in the following section shall for the purpose of these specifications have the meanings ascribed to them pertaining to traffic signals.

ASA - American Standards Association.

ASTM - American Society of Testing Materials.

AWS - American Welding Society.

AWG - American Wire Guage

Backplate - A thin strip extending outward parallel to the signal face on all sides of a signal housing to provide suitable background for the signal indications.

City Traffic Engineer - David R. Abbey, P.E., 8th Floor, Municipal Plaza (207-7720).

Construction Traffic Coordinator - The person in charge of construction barricading and barricade inspections.

Controller Assembly - The complete assembly for controlling the operation of a traffic signal consisting of a traffic signal controller unit and all auxiliary and external equipment housed in a weatherproof cabinet.

Controller - That part of the controller assembly which performs the basic timing and logic functions for the operation of the traffic signal.

CPS - City Public Service Board.

Detector - A device for indicating, when attached to a loop or pushbutton, the passage or presence of vehicles or pedestrians.

FHWA - Federal Highway Administration.

Flasher - A device used to open and close signal circuits at a repetitive rate.

Flash Operation - This feature discontinues normal signal operation and causes a predetermined combination of flashing signal circuits.

IMSA - International Municipal Signal Association.

Inspector - The Inspector referred to is the person appointed by the City in responsible charge of inspection of the traffic signal elements of a project. On a privately funded project, this person may be an Engineer representing the owner under the guidance of the Traffic Design Engineer.

ITE - Institute of Transportation Engineers.

Luminaire - The assembly which houses the light source and controls the light emitted from the light source for roadway illumination. Luminaires consist of a housing, lamp socket, reflector, and glass globe or refractor.

Manual Operation - The operation of a signal controller unit by means of a hand operated switch.

Mounting Assembly - The framework and hardware required to mount the signal face(s) and pedestrian signal(s) to the pole.

MUTCD - Manual on Uniform Traffic Control Devices.

NEC - National Electrical Code.

NESC - National Electrical Safety Code

NEMA - National Electrical Manufacturer's Association.

Pedestrian Signal - A traffic control signal for the exclusive purpose of directing pedestrian traffic at signalized locations.

Punch List - The list compiled by the City for the Contractor noting deficiencies needing attention prior to final acceptance of the traffic signal system.

Phase - A part of the time cycle allotted to any traffic movement or combination of movements receiving the right-of-way during one or more intervals.

TxDOT - Texas Department of Transportation.

Signal Face - An assembly controlling traffic in a single direction and consisting of one or more signal sections. Circular and arrow indications may be included in a

signal assembly. The signal face assembly, also called a signal head, shall include the visors and backplates where specified or shown on the plans.

Signal Indication - The illumination of a signal section or other device, or of a combination of

sections of other devices at the same time.

Signal Section - A complete unit for providing a signal indication consisting of housing, lens, reflector, lamp receptacle, and lamp.

Signal Systems Engineer - Person in charge of the Signal Systems Section, responsible for system timmings.

TMUTCD - Texas Manual on Uniform Traffic Control Devices.

Traffic Design Engineer - Person in charge of Traffic Engineering Design section for the City of San Antonio.

Traffic Operations Engineer - Person in charge of the City Traffic Signal and Sign Maintenance Shop. (207-7765)

UL - Underwriters Laboratories.

Vehicle - Any motor vehicle normally licensed for roadway use.

REGULATIONS AND CODES:

All electrical equipment shall conform to the standards of the National Electrical Manufacturer's Association (NEMA), the National Electric Safety Council (NESC), Underwriter's Laboratories (UL), or the Electronic Industries Association (EIA) where applicable.

All materials and workmanship shall conform to the requirements of the latest revision of the National Electric Code (NEC), Illumination Engineer's Society (IES), standards of the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), requirements of the plans, Traffic Signal Special Specifications, Special Provisions, and to any other codes, standards, or local ordinances which may apply. Whenever reference is made to any of these standards, the reference shall be considered to mean the code, ordinance, or standard that is in effect at the time of construction.

INSPECTIONS PROCEDURES:

Prior to beginning any work on any City traffic signal facility, the Contractor shall notify the Traffic Operations Engineer at 207-7765 one week in advance. Under no circumstances will the City accept work done without this prior contact being made.

The Construction Inspector shall be responsible for coordination and inspection of all elements of the traffic signal system. The only persons authorized to modify that Inspector's directions are the Traffic Design Engineer or City Traffic Engineer.

Final inspection on City as well as privately administered projects, for the purpose of generation of the Punch List, shall be conducted by the Traffic Design Engineer or his designated agent as well as the Contractor and City Construction Inspector. The Contractor shall notify the Traffic Design Engineer 48 hours in advance of a desire for final inspection (207-7758). It will be the Contractor's responsibility to have a bucket truck available at the Final Inspection for inspection of any overhead signal resources. After the Punch List items are completed the signal may be put into Flash Operations for a period of time described by the Engineer. A Final Letter of Acceptance of the traffic signal will be initiated by the Traffic Design Engineer to the Construction Inspection Section, after the signal has functioned properly for a period of time.

EQUIPMENT SUBMITTALS:

The Contractor shall note that the approval by the Traffic Design Engineer is required prior to installation of any equipment that is to be used.

The Contractor shall submit two copies of a complete material list for approval which shall conform to these specifications. The list shall state all relevant information regarding materials and equipment to allow the City to procure exact replacements of any items supplied on the project. The submittals must be complete enough to be able to judge if items comply with the features specified and shall be evaluated by the Contractor prior to submittal to eliminate rejection of obviously wrong items.

The materials on the list shall be identified by the contract project name or number, bid item number, catalog part numbers, catalog cuts, shop drawings, trade names, and schedules of other pertinent information. The materials from catalog cuts shall be clearly indicated by the Contractor. Any material designation used in the contract documents shall be so noted on the material list. If requested, the Contractor shall submit shop drawings for review and approval.

It is the City's intent to keep a "pre-approved" list of equipment for traffic signal projects. The intent is to streamline the approval process by making information available to the Contractor of items that have been previously approved under these specifications. This list is in no way to be construed as an endorsement of any brand or product. This list is available from the Traffic Design Engineer, and use of the list does not relieve the Contractor from responsibility to comply with the specifications of a particular project. The maintenance of this list is at the discretion of the Traffic Design Engineer, and the Contractor should be prepared to provide submittals of all equipment as required herein.

The Contractor shall be allowed to substitute a reference to an item in the "pre-approved" list in lieu of a catalog data sheet, if he desires, and if the Traffic Design Engineer has provided such a list. Such reference shall be sufficiently complete for the City to

judge which item is being proposed. The Contractor may also be asked to submit additional documentation from an independent testing lab attesting that the material submitted meets or exceeds the required specifications.

There shall be no substitutions for any of the materials on the submittal without the prior written approval of the Traffic Design Engineer. Proposed changes to the approved materials submittal shall be submitted in writing. If requested, the Contractor shall submit samples of proposed materials for testing and evaluation by the City. The City reserves the right to reject an incomplete or unclear material list or submittal. Installation of equipment not corresponding to the submittal shall be grounds for rejection of the equipment and replacement with approved materials at no cost to the City, even if the non-approved material might otherwise have been approved had it been properly submitted.

Submittals shall be delivered to the Traffic Design Engineer as soon as possible after signing of the contract. Payments to the Contractor may be held if the submittal process is not completed in a timely fashion, considering no equipment can be installed without all submittals being approved.

Submittals shall be provided for the following equipment:

Traffic Paint
Preformed Plastic Markings
Pull Boxes & Lids
Pedestrian Signals
Signal Heads
Lamps
Backplates
Signal Mountings
Detector Modules
Conflict Monitors
Load Switches
Controller and Cabinet
Wood Poles
Span Wire
Pedestrian Pushbuttons and Signs
Loop Wire
Loop Sealant
Wire and Cable
Conduit and Fittings
Warning Tape
Metal Splice Boxes
Service Pedestal
Service Box
Surge Arrestors
Breakers
Steel Poles
Anchor Bolts
Sign Materials
Sign Mounting Brackets

BARRICADING:

Barricading shall be provided by the Contractor as provided for in the plans and requested by the Traffic Design Engineer, Inspector, and Construction Traffic Coordinator. The Contractor shall supply his own barricades or employ a legitimate barricading company for this purpose, supplying the Inspector with the responsible party's 24-hour telephone number for emergencies.

If the Contractor elects to do his own barricading, a traffic control plan is required 48 hours (excluding weekends) in advance for approval. (Ref Item 530 Barricades, Signs and Traffic Handling.

Any lane closures or total closures of streets or existing sidewalks must be approved in advance. A 72-hour notice is required on all lane closures and/or total closures.

No sidewalks in the downtown area shall be closed.

No closures or partial closures shall occur during the peak hours of 7:00 am to 9:00 am and 4:00 pm to 6:00 pm, weekdays.

It is the Contractor's responsibility to see that all traffic control devices are properly installed and maintained. All locations and distances shall be in conformance with the barricading details supplied by the Traffic Design Engineer, the Construction Traffic Coordinator and the Texas Manual On Uniform Traffic Control Devices.

Any time a Contractor's vehicle occupies a street open to vehicular traffic, or during the work in the street for the purpose of hanging heads, erection of poles, cutting and installation of loops, or any other such work, adequate advance warning signs and barricades or cones shall be used as required by the Texas MUTCD. Additionally, all locations not in a road project shall have the SIGNAL CONSTRUCTION AHEAD signs and END CONSTRUCTION signs on all approaches of the intersection having the new signals or modification installed.

Any trenches left overnight as well as any foundations that do not have poles sitting on them or any other such hazard to the public shall be adequately covered and barricaded with reflective standard barricades equipped with warning flashers or as directed by the Engineer.

Reflectorized signs shall be constructed of retro-reflective sheeting and shall be maintained to meet the appearance, color and reflectivity requirements. Paints and coloration of signs shall be equal to the TxDOT's standards. All traffic control devices shall conform with the Texas Manual on Uniform Traffic Control Devices

for Streets and Highways. Contractors shall furnish copies of certifications from manufacturers of the lights that the warning lights meet the requirements of the ITE Standard for Flashing and Steady Burn Warning Lights, if requested.

Signs erected on portable supports normally mean signs which are used during the day to warn or guide traffic through and/or around the actual construction area, but at the end of the day such signs are either removed or turned away from the view of traffic. Portable supports shall be as shown in the detail. Signs required for nighttime usage should not normally be mounted on temporary supports, except when approved by the Inspector. Signs erected on fixed supports for use on construction projects normally mean signs that are to remain in place for both day and night usage to regulate, warn and guide traffic in advance of and within the limits of the project including the crossroad approaches. However, under certain conditions, such as where a sign may be required for a few days duration and then is no longer needed or where a sign is moved from location to location every few days or where it is not practical or desirable to provide a fixed mounting, such signs may be erected on a temporary support. Signs erected on temporary supports should be at a minimum height of 3 feet [1 m]. Signs erected on fixed supports should be at a minimum height of 7 feet [2.1 m]. All regulatory signs shall be erected at least 7 feet [2.1 m] above the ground. Posts for fixed supports should be set in the ground without concrete footings.

Where portable or temporary supports require the use of weights to keep the sign or barricade from turning over, the use of some type of sandbag is recommended. The use of pieces of concrete, rocks, iron, steel or other solid objects will not be permitted.

Signing shown on the details is typical and may be adjusted to fit field conditions.

No more than 2 signs shall be placed on a barricade.

The Contractor shall be responsible for maintaining appropriate visibility of new or existing signals. The contractor will be responsible for temporary signals or signal relocations necessary to meet the visibility requirements in the Texas MUTCD when traffic is detoured to another part of the roadway even if no other signal work is part of the Contract.

SIGNAL SHUTDOWNS:

At any location where an existing signal is to be temporarily shut down for the sake of changing from the old controller or service to the new controller or service, the Contractor shall be responsible for arranging and bearing the cost of duly- constituted peace officers in their jurisdiction for directing traffic. Security guards are not considered as police officers and shall not be used for this purpose. Signal shutdowns shall not begin prior to 9:00 am on weekdays (holidays excluded) and shall be avoided from 4:00 to 6:00 pm weekdays (holidays excluded).

Additionally, the City shall not allow an existing traffic signal or flasher system to be turned off and STOP signs used to control traffic. The Contractor shall plan ahead and consider this when planning his project strategy. It is suggested that the new poles be installed as soon as possible and possibly temporarily wired overhead to avoid this problem. Except in highly unusual circumstances, the City will require the Contractor to place the new signals in operation before the old signals are removed. If temporary signals cannot be avoided, the Contractor will be responsible for all temporary signals.

CITY SUPPLIED MATERIALS:

The City shall not supply nor lend out equipment on a contract-deduction basis or any other basis unless such arrangement is so stated in the plans or approved by the Traffic Design Engineer.

UTILITY LOCATIONS:

The locations of utilities shown on the plans are approximate. All involved utilities, tunnels, and storm drains may not be complete on the plans, and the Contractor shall be responsible for obtaining any additional information from the applicable sources prior to construction, and determining the accuracy and adequacy of such information necessary for his performance of the work. Damage to any utility or existing facilities (including detector loops not involved in the project) shall be repaired or replaced at the Contractor's expense.

Existing loop detectors damaged or broken by the Contractor shall be replaced by him at no expense to the City, unless other arrangements have been made in writing with the City.

MAINTENANCE DURING CONSTRUCTION:

Any and all maintenance, reattachments to CPS poles or City poles, temporary signals, relocation of signals over lanes, or pole relocations or removals shall be by the Contractor. The City shall have no maintenance or construction responsibilities during construction except for the timing in the controller cabinet itself.

During detours, traffic signal heads must be repositioned by the Contractor to the minimum requirements of the Texas Manual on Uniform Traffic Control Devices and to the directions of the Traffic Design Engineer and/or Inspector.

Where left turn arrows presently exist and a one-lane detour road will be built as a temporary construction detour, the Inspector, Traffic Operations Engineer, or Traffic Design Engineer may require the arrow(s) be eliminated temporarily by the Contractor to facilitate traffic movement.

In the event that the Contractor or his sub-contractor damages any traffic signal facilities to the point that the signal installation is inoperative it shall be the Contractor’s responsibility to set temporary Stop signs

as soon as possible. It will also be the Contractor's responsibility to have an off-duty police officer on the site within two hours of the non-functioning signal, if the signal is not repaired to the Engineer's satisfaction within the first hour. In the event that the Contractor is unable to accomplish the above, the City of San Antonio shall at it's option send an on-duty police officer to site and have either the City's Traffic Signal Maintenance Section or another independent private traffic signal Contractor facilitate the repairs. Any and all cost incurred by the City of San Antonio to repair the damaged signal facilities shall be the responsibility of the General Contractor for the project.

SIGNAL TURN-ONS:

Signals shall be turned on when the City has determined that the location is in adequate condition (wiring, signals, service, etc.) to be turned on safely. The Traffic Design Engineer shall make this determination.

The City's policy on new traffic signals, where there were none before this project, is to turn on the new system and let it remain in the Manual Flash mode for approximately one week before the system is switched on to cycling mode.

The Contractor shall ensure that service has been provided and that all wires are terminated in the cabinet. At that point he shall arrange with the Inspector for the Traffic Design Engineer to conduct an inspection to verify that there are no other circumstances that would delay the turn-on. The Traffic Design Engineer shall coordinate turning the signal on to the flash mode through the Inspector. The Contractor shall have personnel and a bucket truck at the site on the day the Traffic Design Engineer turns the signal on to flashing operation for the purpose of uncovering the signals and any necessary overhead work or inspections. ***The Contractor shall not place any signal in operation, either cycling or flashing, under any circumstances!***

PRESERVATION OF SOD, SHRUBBERY AND TREES:

The Contractor shall assume full responsibility for the preservation of all sod, shrubbery, and trees at the site during the installation. When it becomes necessary to remove any sod, shrubbery, or tree branches, the Contractor shall obtain permission from the owner.

All sod and shrubbery that are removed shall be carefully preserved and replaced in their original position. Damaged sod or shrubbery shall be replaced by the Contractor at his expense.

LOCATING OF FACILITIES:

The Contractor shall locate poles, controllers, etc., as shown in plans. Slight (less than three feet [1 m]) deviation to avoid existing utilities is permissible, unless the new location would move the pole too close to the roadway, obstruct the view of another traffic control device, or otherwise not conform to the intent of the plans. Large deviations must be approved by the Traffic Design Engineer. The Contractor shall bear in mind that electrical plans are somewhat diagrammatic in nature when it comes to conduit routing and adjustments which may be necessary in the field.

REMOVAL AND REPLACEMENT OF CURBS AND WALKS:

The Contractor shall secure permission from the Inspector before cutting into any curbs and sidewalks. Sidewalk slabs that require conduit or other facilities to be placed in or beneath them shall be neatly sawcut at the closest expansion or cold joint and the entire slab removed and replaced. Sawcutting slots through slabs is considered unsightly and will not be tolerated. Exceptions to this may be approved by the Traffic Design Engineer only on conduit runs in excess of 50 feet [15 m] that are not bored.

After the work is complete, the Contractor shall restore facilities which have been removed to the equivalent of their original condition or better.

PERMITS:

The Contractor shall obtain all permits and inspections as required. Cost of these permits are the responsibility of the Contractor and are subsidiary to the various items in the project.

SALVAGED EQUIPMENT:

Equipment not reused in the new signal system shall be removed by the Contractor and poles, signals, cabinets and contents, signal wire, ped signals, signs, and ped buttons salvaged to the City Traffic Design Shop.

The Contractor shall call 207-7765 48 hours prior to proposed delivery to arrange for the receipt of same by the City. The Contractor shall make a complete listing of the items salvaged and present it upon delivery of the items.

All equipment damaged or destroyed by improper care, handling, or transport shall be replaced with new equipment. The Contractor shall remove from the jobsite and dispose of any nonsalvaged items and old wire. Holes resulting from the removal of pull boxes, foundations, and other materials shall be backfilled and compacted with material equivalent to the surrounding material and the surface made to match the surrounding surface.

CLEANUP:

The Contractor shall leave the intersection area, right-of-way, and any work or storage areas in broom clean condition. Dirt areas shall be raked clean. No scraps or debris of any kind shall be left at the site.

WARRANTY:

The Contractor shall guarantee all items of workmanship and materials to be free from defects for a period of one year from the date of acceptance.

AS-BUILT PLANS:

The Contractor shall supply the Traffic Design Engineer with redlined blueprints of any and all field changes and alterations for a file copy on all projects with traffic signals for the City. This set of As-Builts is in addition to and separate from any other As-Built requirements in that contract.

MEASUREMENT AND PAYMENT:

Items covered under this specification shall be covered under the lump sum per intersection, or lump sum per project (on some road projects) per the bid item listing for Traffic Signal Conditions.

BID ITEM:

Item 600.1 Traffic Signal Conditions (Per Inter.)

Item 600.2 Traffic Signal Conditions (Lump Sum)

ITEM 601
CPS INSURANCE

The purpose of this specification is to describe additional insurance required, in addition to the insurances required in the Standard Contract by the City, applicable any time the Contractor has cause to contact a CPS pole for interconnect attachment, joint-use for a span-wire traffic signal installation, or other work on CPS owned poles.

STANDARD MANUFACTURER'S AND CONTRACTOR'S LIABILITY INSURANCE:

The Contractor shall furnish evidence to the City that, with respect to the operations he performs, he carries regular Contractor's Liability Insurance providing for a limit of not less than one million dollars ($1,000,000) for all damages arising out of bodily injuries to or death of one or more persons in any one occurrence, and Property Damage Liability Insurance providing for a limit of not less than five hundred thousand dollars ($500,000) for all damages arising out of injury to or destruction of property in any one occurrence and subject to that limit per occurrence, a total (or aggregate) limit of one million dollars ($1,000,000) for all damages arising out of injury to or destruction of property during the policy period.

If any part of the work is sublet, similar insurance shall be provided by or in behalf of the subcontractors to cover their operations.

CONTRACTOR'S PROTECTIVE LIABILITY INSURANCE:

The Contractor shall furnish evidence to the City that, with respect to the operations performed for him by his subcontractors, he carries in his own behalf regular Contractor's Protective Liability Insurance providing for a limit of not less than one million dollars ($1,000,000) for all damages arising out of bodily injuries to or death of one or more persons in any one occurrence, and Protective Property Damage Liability Insurance providing for a limit of not less than five hundred thousand dollars ($500,000) for all damages arising out of injury to or destruction of property in any one occurrence, a total (or aggregate) limit of one million dollars ($1,000,000) for all damages arising out of injury to or destruction of property during the policy period.

CPS' PROTECTIVE LIABILITY AND PROPERTY DAMAGE AND PHYSICAL DAMAGE TO PROPERTY INSURANCE:

The Contractor shall maintain the kinds of insurance with minimum limits of insurance as set forth and shall include CPS as an “additional insured.” The policies with the “additional insured” endorsement shall contain a “cross liability” provision worded as follows:

“It is understood and agreed that in the event of claims being made by reason of personal injuries and/or property damage suffered by any employee or employees of the Named Insured or Additional Insured herein for which another Named or Additional Insured herein is or may be liable, then this policy of insurance shall cover such Named Insured or Additional Insured against whom a claim is made or may be made in the same manner as if separate insurance policies had been issued to each Insured or Additional Insured named herein.”

These policies shall have contractual coverage sufficiently broad to insure the indemnity provisions herein described.

The Contractor undertakes to permit no subcontractor to enter upon or continue the performance of work unless such subcontractor is and remains insured in accordance with the herein stated requirements. Contractor shall indemnify CPS for any loss suffered by the failure of any subcontractor to be so insured.

Contractor hereby agrees to indemnify CPS against any loss and/or expense, including reasonable attorney's fees, arising or resulting from any and all claims against it for damages on account of bodily injuries and/or death accidentally suffered or alleged to have been suffered by any person or persons (including all officers and employees of the Contractor) during the progress of said work, however same may have been caused, and regardless of whether or not same may be caused or contributed to by the negligence of CPS, and Contractor hereby releases CPS from all liability to it on account of any such injuries, death and/or damages, occurring during the progress of the work.

Before commencing the work, the Contractor shall furnish CPS with certificates of policies showing the above coverages and providing for at least thirty (30) days of prior written notice by registered mail to CPS of cancellation or modification.

Additionally, copies shall be filed with the Department of Public Works, Capital Projects Management , prior to starting any work.

The insurance as specified above shall remain in effect until all work required to be performed under the terms of the contract is completed and formally accepted by the City.

MEASUREMENT AND PAYMENT:

Unit Price Bid–CPS Insurance shall be measured for payment as a total lump sum for the project (on some road projects) or per each intersection involved in this project requiring this insurance (as stated in the bid list). Therefore, any deletions or additions of intersections will result in a deduction or additional payment to the Contractor, based on the number of intersections in the contract that require this insurance.

BID ITEM:

Item 601.1: CPS Insurance (Per Intersection)

Item 601.2: CPS Insurance (Lump Sum)

ITEM 603
PULL BOXES

The purpose of this specification is to describe a pull box (junction box) with cover and extension (if specified) for use in an underground traffic signal conduit system. The box shall be used for terminating and beginning conduit runs of various sizes, and accessibility of cable and wire installation and servicing. For Contract Projects, the work shall consist of furnishing and installing pull boxes, lids, excavation, stub outs, 1inch [25 mm] drain stone, tar paper, concrete collar, backfilling, barricading, sign and post (where applicable), labor, and incidentals in accordance with the plans and these specifications.

MATERIALS:

Pull boxes and extensions (where specified) shall be constructed of reinforced polymer concrete (RPM) or Composolite, of the nominal dimensions as indicated in Table 1 for footed box with lids.

No concrete boxes or lids shall be accepted.

All pull box lids shall fit neatly inside of the upper lip of the box frame without any portion projecting above the upper lip. The pull box shall have a minimum depth of 1 3/4 inches [44 mm]. The lid shall produce no undue noise when run over by a vehicle. All lids shall bear the wording "TRAFFIC" or "TRAFFIC SIGNAL", and shall have a means for being secured to the box.

Lids shall generally be made of polymer concrete or Composolite material. Boxes and lids shall be concrete gray in color. Boxes shall be able to withstand a 15, 000 pound [6 802.5 kilogram] load on a 10" x10" [254 mm x 254 mm] area. Because of vandalism, cast iron and steel lids will not be acceptable. All lids shall have a non-slip, non-corrosive (rust) surface, and shall have lifting lugs and bolt down devices. The dimensions and general appearance of the pull boxes shall conform to the detail which is provided in the Plans.

CONSTRUCTION METHODS

All pull boxes shall be installed according to the Standard Detail for pull box installation.

Normally, pull boxes shall be installed level with the adjacent grade, be it a sidewalk, paved area, or dirt. In no cases shall boxes be installed such that they protrude above grade and constitute a tripping hazard. Any such boxes determined to be in such a condition will require resetting according to the Inspector's directions. Unusual grades or conditions will require unusual procedures. Such locations shall be noted to the Inspector and he will so direct the Contractor.

The Contractor shall protect all pull boxes until notified of final acceptance by the City. Any boxes damaged prior to that time shall be the responsibility of the Contractor to replace as directed, at no additional cost to the City. The Inspector and Traffic Engineer shall determine the basis for rejecting damaged pull boxes and lids, and that decision shall be final.

Pull boxes shall not be bolted down until after generation of the Punch List, so the Traffic Engineer and the Inspector are able to examine the inside of each box without the use of tools.

Pull boxes shall be installed at the locations shown in the plans unless a conflict exists at that location. Conflicts include all driveways and other facilities which allow vehicles to drive on the box or which restrict access to the box by maintenance crews. In locations where the pull box must be constructed in a driveway, specific approval shall be obtained from the Traffic Engineer before construction of the box or conduits leading to it begins. A pull box located in a driveway may require a steel lid which must be approved by the Traffic Engineer. No expansion material will be allowed around pull boxes.

Pull boxes installed in uncurbed areas shall have the marker sign and post installed as shown on the Standard Detail.

MEASUREMENT AND PAYMENT

Unit Price Bid: Pull boxes shall be measured for payment by the number of units each, of the size specified, complete in place in accordance with the plans and specifications. The accepted number of pull boxes will be paid for at the contract unit price which shall be full compensation for the pull boxes, installation, stub outs (if required) and incidentals (such as slab removal/replacement where applicable).

BID ITEMS:

Item 603.1: #3 1/2 Pull Box

Item 603.2: #5 Pull Box

Item 603.3: #7 Pull Box

Item 603.4: #5 Pull Box Extension

Item 603.5: #7 Pull Box Extension

TABLE 1

Type	Width [mm]	Length [mm]	Height [mm]
#3 1/2	10 1/4" [260]	10 1/4" [260]	12" [305]
#5	12" - 13" [305 - 330]	23 5/8" - 25" [600 - 635]	12" [305]
#7	16 3/8" - 22" [416 - 559]	29 3/8" - 33 1/2" [746 - 850]	12" - 18" [305 - 457]

ITEM 605
PEDESTRIAN SIGNALS

The purpose of this specification is to describe a pedestrian signal for use in a traffic signal system. The work shall consist of furnishing and installing pedestrian signals as described herein and on the project plans.

MATERIALS:

Unless otherwise specified, all pedestrian signals shall be international symbolic, displaying MAN/HAND indications. The general construction shall include a single piece cast aluminum housing, a single piece double parabolic reflector, a two symbol, two color message lens, a single piece cast aluminum swing down door frame, a blankout eggcrate type sun visor, two 60W-67W lamps conforming to the Special Specification 608, "Traffic Signal Lamps," and appropriate sockets. The design shall optimize performance per unit of energy consumed.

Optically, the pedestrian signal shall be capable of displaying, brightly and uniformly, the alternate message symbols "HAND" in Portland Orange and "MAN" in Lunar White while being subject to any ambient light conditions. Under any ambient light conditions, the messages shall blank out when the signal is not energized.

In order to facilitate installation and maintenance, the signal shall be designed so that all components are readily accessible from the front by merely opening the door.

The maximum overall dimension of the signal shall be 18 1/2 inches [470 mm] wide, 18 3/4 inches [476 mm] high, and 9 inches [229 mm] deep including eggcrate-type visor and hinges. The distance between the mounting surfaces of the upper (non-shurlock) and the lower (shurlock) openings shall be 15 3/4 inches [400 mm]. To facilitate wiring, the head shall be cast without interior panels as a single open chamber. The divider for the MAN and HAND reflectors shall be molded into the reflector unit.

Lens shall be 0.25 inch [6 mm] polycarbonate plastic with C-64 or C-66 pattern texture on the outside surface to eliminate message "hot spots", or glass, conforming to industry standards for pedestrian signal lenses.

All pedestrian signals shall be supplied Federal Yellow in color from the factory.

Eggcrate-type visors shall be constructed of black anodized aluminum or polycarbonate plastic with the black color molded into the material. The visor shall consist of vanes arranged in an array which creates small openings to allow visibility of the indications while shading the lens from direct sunlight. The visor vanes shall be horizontal, vertical, or diagonal, and shall be .030 inches ± .005 inches [0.76 mm ± 0.127 mm] thick. The maximum horizontal opening in the visor shall be 1.6 inches [41 mm], the maximum vertical opeining shall be .6 inches [15 mm], and the maximum area of each opening shall be .5 x .5 inches (13 mm x 13 mm]. The depth of the visor shall be no less than 1.4 inches [35 mm]. The vanes shall be bonded to each other such that rattling is not possible, and the visor shall be mounted in a frame adquate to keep the visor rigid and straight regardless of mounting attitude or wind conditions.

Where audio devices are specified in the plans or Invitation for Bid, they shall be Mallory Sonalert #SC110D (1900 cycles per second) and #SC110 (2900 cycles per second). Audio devices shall be installed inside the signal housing, with the tone emitter exposed through the bottom of the signal head housing, looking down. The location of each pitch shall be shown in the plans.

CONSTRUCTION METHODS

Pedestrian signals shall not be mounted perpendicular to the street, on the street side of the pole unless so specified nor mounted in such a way as they are exposed to strikes by passing or turning vehicles.

MEASUREMENT AND PAYMENT:

Pedestrian signals shall be measured for payment by the number of units each, in accordance with the plans and specifications. The accepted number of pedestrian signals will be paid for at the contract unit price which shall be full compensation for the pedestrian signals, installation, and incidentals.

BID ITEMS:

Item 605.1: Pedestrian Signal

ITEM 607
TRAFFIC SIGNAL HEADS

The purpose of this specification is to describe minimal requirements for traffic signal heads for use in traffic signal or warning beacon systems.

The work shall include furnishing and installing traffic signal heads, including lamps, visors, and backplates if shown on the plans, in accordance with these specifications and the project plans.

MATERIALS:

The traffic signal heads shall be in accordance with the latest revision of ITE Technical Report No. 1, except as noted in these specifications.

Each traffic signal face shall consist of a number of sections rigidly fastened together in such a manner as to present a continuous pleasing appearance.

The electrical and optical system of the signal head shall, unless otherwise specified, be designed for operation from a power supply of 120 volts, single phase, 60 Hz AC and utilize the specified lamps. Signal face and signal arrangement shall be as detailed in the project plans..

A standard signal face shall consist of up to five lenses, each mounted in an individual housing case. The signal faces shall conform to the latest revision of the "1980 Texas Manual on Uniform Traffic ControlDevices for Streets and Highways." The arrangement shall be designated as shown in the detail or on the project plans.

The signal housing cases shall be one-piece polycarbonate resin material or aluminum with sides, top and bottom integrally molded. The housing shall be at least 0.15 inches[4 mm] thick and shall be ribbed to produce the strongest possible assembly consistent with light weight. The terminal blocks shall either be securely mounted or integrally molded into the housing. The top signal head of every signal head arrangemnet shall have two six postion terminal blocks.

The signal housing cases, fittings, and accessories shall be of non-corrosive, rust-resistant materials capable of withstanding constant exposure to sunlight and corrosive atmospheres, including salt air, and shall provide adequate strength for the purpose for which it is intended.

Polycarbonate resin material shall be new (virgin). Reprocessed polycarbonate material shall not be acceptable.Provisions shall be made for accommodation of the particular type of mounting specified and attachment of doors, optical units, and other such accessories as may be specified for the particular installation. All signal housing cases, together with doors, lenses, and mounting attachments, shall comprise a dust and moistureproof housing for optical units, connecting wiring and terminal block, and shall be supplied Federal Yellow in color. The housing cases shall be of such construction as to assure permanent alignment of the lens in the signal face. Design of door, housing, and visor shall be such that no light is visible in the profile view of the signal head.

Traffic control signal housing cases shall be of the sectional adjustable expandable type. The assembled housings for each signal face shall consist of individual sections, each designed for housing a single complete optical unit. Individual signal sections shall be rigidly attached to each other for a "single face" with at least four fasteners between each section – either machine screws or bolts, nuts, and washers. Complete signal faces shall provide positive locked positioning when used with serrated brackets, mast arm, or span-wire attachments.

Portions of cases providing for attachment to support arms shall be molded with large bosses for the supporting arms. Each housing case shall be so attached to its support arm that it will be adjustable by rotation about its vertical axis in such a manner that any pair of adjacent faces may be adjusted individually to give indications in two directions as close as 15 degrees apart and may be rigidly clamped in any position throughout the range of adjustment. Provisions shall be made for carrying wires enclosed within the support arm attachment.

Both the top and bottom of each signal housing case shall be provided with an opening to accommodate 1 1/2" [38 mm] pipe brackets. A locking ring shall be integrally cast or molded around the bottom opening. Around the top opening shall be either an integrally cast or molded locking ring or a separate splined locking ring designed to fit into notches. The locking rings shall have a minimum of 46 evenly spaced teeth and shall be so designed that the top and bottom rings will mate to provide a perfectly aligned signal head with a flush connection between the outer circumference of the sections. Any open end of an assembled signal head shall be plugged with an ornamental cap and gasket. The housing door of each signal housing shall be a one-piece polycarbonate resin material or aluminum with an approximate 8-inch [203 mm] or 12-inch [305 mm] diameter circular lens. The door must be of the same material as the housing. The door shall be attached to the housing by means of two stainless steel hinge pins, or by polycarbonate hinge pins which are an integrally molded part of the door.

A means shall be provided for opening and closing the door without the use of special tools. Wing screws shall have a flat bearing surface or stainless steel flat washer to prevent gouging of the housing door by the wing screws. Wing screws shall remain captive in the housing or door when the door is open.

Each signal housing door shall be equipped with an easily detachable standard tunnel visor, unless otherwise specified or shown on the plans. The visor shall be polycarbonate resin material or aluminum, of the same color as the signal head to which it shall attach. The visor shall be rigidly attached to the door with rust-resistant connections in a manner that will prevent the leakage of light and moisture throughout the periphery of attachment. The visor must be removable without opening the signal housing door.

Unless otherwise specified or shown on the plans, all visors shall have a downward tilt of 2 to 8 degrees and extend outward from the face of the door a minimum of 7 inches [178 mm] for 8-inch [203 mm] diameter lenses and a minimum of 9 1/2 [241 mm] inches for 12-inch [305 mm] diameter lenses. All visors shall have an approximately 60 degree opening at the bottom to prevent the accumulation of dirt and bird's nests. All visors shall be Federal Yellow on the exterior and flat black on the interior. Visors shall be easily removed and replaced without damage to the visor or signal head.

Each lens shall be provided with an optical unit consisting of a reflector assembly with leads to the terminal block together with all bolts, nuts, screws, clips, hinges, lugs, and incidentals necessary to mount the various parts of the optical system.

The optical system shall consist of a lens which shall be permanently marked in an inconspicuous manner indicating the top of the lens, and the name or logo of the manufacturer. Lenses shall be glass or polycarbonate and conform to current ITE Standards.

The lens and optical system shall be capable of withstanding the heat generated when constantly illuminated without distortion or discoloring of the lens. Lens and reflector design shall conform to ITE Standard (ITE Report No. 1) and to American Standards Association #D-10.1-1958 UDC 657.057 optical specifications.

Each lens and reflector assembly shall be designed such that the and lens, when the door is shut, form a sealed unit via the use of a gasket.

The reflector shall be a parabolic unit, made of Alzac material. Reflectors shall be made of specular Alzac aluminum with an anodic coating minimum thickness of 0.0001 inches[0.00254 mm], spun or drawn from metal not less than 0.025 inches [0.635 mm] in thickness with a bead or flange on the outer edge to stiffen the reflector and insure its being held true to shape.

The reflector shall be of the swing-out design on its own hinges to allow it to be swung out separately away from the lens and door.

The reflecting surface shall be free of flaws, scratches, defacements or mechanical distortions.

The lamp receptacle shall be of weatherproof molded construction capable of withstanding without deterioration the high temperatures within the optical unit during operation and shall be provided with a lamp grip to avoid lamps being loosened by vibration. All lamp receptacles shall be located to place the lamp filament in the proper focal position, with respect to the reflector. Lamp receptacles shall be rotatable to place the opening between the filament leads at the 12:00 position.

The reflector holder and lamp receptacle holder shall consist of a structure of such design as to securely hold the receptacle and reflector in their proper places. Materials used shall be rust-resistant material and not subject to corrosion.

Each lamp receptacle shall be provided with two flexible, insulated, color-coded leads not smaller than #18 AWG. These leads shall be securely fastened to the lamp socket and connected to the terminal block by means of solderless wire connectors or binding screws and spade lugs.

Each optical unit shall be wired to a terminal block located in the top signal section. The terminal block shall have a six-position terminal with wires connected and ready for installation. Terminal blocks shall be securely mounted in an accessible position and shall be of weatherproof molded construction, equipped with identified terminals. Binding screws shall be provided for wire connections.

For Contract Projects, all rigid-mount signals shall have backplates. All backplates shall be flat black in color on both sides and be compatible with the signal heads and mounting assemblies to which they attach. Backplates shall be constructed of aluminum or vacuum formed ultraviolet stabilized ABS plastic sheet with haircell finish on front side, at least 0.125 inches [3 mm] in thickness.

All lamps shall conform to Item 608, "TRAFFIC SIGNAL LAMPS."

CONSTRUCTION METHODS

Each signal head shall be mounted at the location and in the manner shown on the project plans.

All traffic signal heads not in use shall be covered with burlap or bagged with black plastic until such time they are activated for traffic use. At locations where no signal had previously existed, new heads shall not be field installed more than one week in advance of the date the installation is to be energized and signal heads placed into service.

All polycarbonate signal heads that are called for on the project plans that are to be attached to a rigid mount on a steel mast arm or post-top mount shall have reinforcing plates inside the signal head at the attachment points.

MEASUREMENT AND PAYMENT

Traffic signal heads shall be paid for at the contract unit price each, of the type specified. Such price shall include the specified type of signal head, visors, lamps, backplates if specified, and incidentals required for a complete installed unit.

BID ITEMS:

Item 607.1: Traffic Signal Head Type 1

Item 607.2: Traffic Signal Head Type 2

Item 607.3: Traffic Signal Head Type 3

Item 607.4: Traffic Signal Head Type 4

Item 607.5: Traffic Signal Head Type 5

Item 607.6: Traffic Signal Head Type 6

Item 607.7: Traffic Signal Head Type 7

Item 607.8: Traffic Signal Head Type 8

Item 607.9: Traffic Signal Head Type 9

ITEM 608
TRAFFIC SIGNAL LAMPS

The work shall consist of furnishing lamps installed in traffic signal and pedestrian signal heads.

MATERIALS:

Lamps to be used in signal faces shall conform to the standards set forth in the ITE publication "Standards for Traffic Signal Lamps" and the following Table.

All lamps shall be rated for 120 volts AC.

Lamps shall be clear and have an aluminum reflector disc. Filament shall either be V-shaped or shall conform to ITE standards for filament shape. Wattage, voltage and manufacturer's name or logo shall appear on each lamp. Lamps shall be filled with gases which contain no less than **80%** Krypton by volume. The supplier shall submit to the City a report by an independent testing laboratory certifying the envelope gas content by volume, the lumen output, and the voltage and current during the lumen test. The Test Reports shall be submitted with the material submittals.

.

CONSTRUCTION METHODS (CONTRACTOR PURCHASING ONLY):

Lamps shall be new and furnished with each new traffic signal face or pedestrian signal.
Lamps shall be installed to the manufacturer's instructions, and so that ITE performance standards are achieved.

MEASUREMENT AND PAYMENT:

Lamps shall be considered as subsidiary to the traffic signal or pedestrian signal item applicable, and shall not be paid for as a separate item unless so specified.

APPLICATION	8" Traffic Signal [203 mm]	12" Traffic Signal [305 mm]
LUMENS	610	1750
USER-HOURS	8000 Min.	8000 Min.
WATTS	60-67	133-135
LT-CENTER	2 7/16" [62 mm]	3" [76 mm]

ITEM 609
OPTICALLY PROGRAMMED SIGNAL HEADS

The purpose of this specification is to describe an optically programmed traffic signal head for use in a traffic signal installation. The work shall consist of furnishing and installing optically programmable traffic signal heads complete with lamps in accordance with the project plans and specifications.

MATERIALS:

The signal head shall employ no louvers or hoods to obtain this programmable limitation. Visors shall be provided to eliminate extraneous light falling on the lens. The projected indication may be selectively visible or veiled anywhere within 15 degrees of the optical axis. The lamp shall be a nominal 150 Watt, 120 volt AC, 3-prong sealed beam having an integral reflector. The lamp shall have an average rated life of at least 6000 user-hours.

The optical limiter shall provide an accessible imaging surface at focus on the optical axis for objects 900 - 1200 feet [274 m - 366 m] in distance. It shall permit an effective veiling mask to be variously applied as determined by the desired visibility zone.

The objective lens shall be a high-resolution planar incremental lens. The lens shall be symmetrical in outline so that it may be rotated to any 90 degree orientation throughout the optical axis. The optical system shall accommodate projection of diverse, selected indicia to separate portions of the roadway such that only one indication will be simultaneously apparent to the viewer. The projected indication shall conform to ITE Transmittance and Chromaticity Standards.

The exterior color of the signal head with the exception of the inside of the visors shall be Federal Yellow. The insides of the visors shall be flat black. The complete signal head shall consist of three or more sections as shown on the plans (except for Type 9 Lane Control Signals). Heat-resistant tape or other masking material shall be provided in sufficient quantity to adequately tape or mask all sections at the direction of the Engineer. Signal Head arrangements and designations are shown in the attached sketch or in the Plans.

Lamp fixture shall comprise a separately accessible housing and integral lamp support, socket, and self-aligning quick-release lamp retainer. Each signal section shall include a terminal block for screw-type attachment of lead wires. Concealed #18 AWG wire shall interconnect all sections to permit field connection within any section.

CONSTRUCTION METHODS

The signal heads shall be mounted as shown on the project plans. Programmed heads shall be aimed and visibility programmed per the directions of the Traffic Design Engineer or his agent. Mounting attachments shall conform to specifications for mounting attachments.

MEASUREMENT AND PAYMENT

Optically programmed signal heads shall be measured for payment by the number of heads each, in accordance with the project plans and specifications. The accepted number of optically programmed signals will be paid for at the contract unit price which shall be full compensation for the optically programmed signals, installation, and incidentals.

BID ITEMS:

Item 609.1: Optic Programmable Head Type 1

Item 609.2: Optic Programmable Head Type 2

Item 609.3: Optic Programmable Head Type 3

Item 609.4: Optic Programmable Head Type 5

Item 609.5: Optic Programmable Head Type 6

Item 609.6: Optic Programmable Head Type 8

Item 609.7: Optic Programmable Head Type 9

ITEM 611
MOUNTING ASSEMBLIES

The purpose of this specification is to describe mounting assemblies for use in mounting traffic signal heads to poles and span wires. The work shall consist of furnishing and installing mounting assemblies, labor, and incidentals in accordance with the Standard Details and the plans.

MATERIALS:

Mounting assemblies shall consist of 1 1/2 inch [38 mm] standard pipe and fittings, with parts as shown in the Standard Details, Federal Yellow in color, matching the signal heads to which they attach. An exception to the color requirement is the Type VII Astro-Brac, which may be stainless steel color. All members shall be so fabricated that they shall provide plumb, symmetrically arranged, and securely fastened assemblies. Serrated lock washers shall be used. The types of mountings to be used shall be as noted in the plans and quantities. Cable guides shall be used on all Type III mountings as shown in the Standard Details.

All polycarbonate signal heads on the Type V mounting shall have a reinforcement plate installed inside the bottom section of the signal head. Type VII mountings must have pivot adjustments which are easily accessable using socket wrenches. Mounts with internal locking mechanisms requiring open-end wrenches with limited turning room will not be acceptable. The openings through the pivot for these mountings shall have a passage for wiring of at least 2.25 inches [57 mm] diameter with no obstruction.

CONSTRUCTION METHODS

Each vehicular signal shall be mounted as shown on the plans with respect to pole quadrant. Generally, mountings shall be located such that they are visible in the direction intended without being obscured by other assemblies, and **attached to the side of the pole away from the curb side.**

Failure to attach mountings according to these specifications and the plans shall be cause for

rejection of misdrilled poles. If the pole is steel, it shall be rejected and replaced with a new pole at the

Contractor's expense. Welding of “mistakes” will not be acceptable.

Mountings damaged during installation may require field painting touch ups. Such painting shall be considered part of the work under this item and shall not be an additional pay item.

No wire feeding a traffic signal head or pedestrian head shall be exposed as it goes into the head, except where a span-wire signal mounting is used. All other wires shall be contained within the mounting assembly, via holes drilled in the mast arm or pole shaft.

Mountings shall be attached to poles using bolt sizes specified in the Standard Details. Strapping to steel poles is only allowed if specified on the plans or specifically allowed by the Traffic Design Engineer. Strapping to wood poles shall not be acceptable.

MEASUREMENT AND PAYMENT

Mounting assemblies shall be measured for payment by the number of units each in accordance with the project plans and specifications. The accepted number of mounting assemblies shall be paid for at the contract unit price for the type of assembly in the bid item list which shall be full compensation for the mounting assemblies, installation, and incidentals.

BID ITEMS:

Item 611.1: Mounting Assembly Type I

Item 611.2: Mounting Assembly Type II

Item 611.3: Mounting Assembly Type III

Item 611.4: Mounting Assembly Type IV

Item 611.5: Mounting Assembly Type V

Item 611.6: Mounting Assembly Type VI

Item 611.7: Mounting Assembly Type VI

Item 611.8: Mounting Assembly Type VIII

ITEM 613
PEDESTRIAN PUSHBUTTON ASSEMBLY

This item specifies pedestrian pushbutton assemblies, associated signs, and pushbutton assembly with the appropriate sign as specified in the Plans.

MATERIALS:

The Pedestrian Pushbutton Assembly shall consist of a normally-open pushbutton switch mounted inside an approved pushbutton housing. The pushbutton switch shall be raised or flush and be a minimum of 3/4 inch [19 mm] in the smallest dimension. The force required to active controls shall be no greater than 5 lbf [22 N] or as approved by the Engineer. The switch shall be an enclosed, SPST, momentary closure type with a rated life of not less than one million actuations. Switching contacts shall be rated at 15 amperes, 120 VAC. Switch shall have screw-type terminals.

The housing shall be of substantial tamper-proof construction, made of cast aluminum alloy, and painted Federal Yellow. The assembly shall be weatherproof and so constructed that it will be impossible to receive any electrical shock under any weather conditions.

The housing shall be approximately 5 inches [127 mm] wide by 12 inches [305 mm] high as shown in the sketch. The housing shall be sized in such a way that a 5 inches by 7 inches [127 mm x179 mm] sign panel may be installed without the sign protruding beyond the edge of the pushbutton housing. The sign shall be drilled and tapped for sign placards according to the dimensions in the sketch. Grommets and brass screws shall be provided for each sign mounting hole.

The housing shall be constructed to allow both banding strap mountings and bolt mountings. The housing shall be supplied with adjustable slots and adapters to provide a rigid mounting using either of the above methods on a pole of 2.5 inches to 14 inches [63 mm - 355 mm] in diameter. The housing shall also allow flush mounting on flat surfaces with adapters removed.

The pushbutton shall be mounted in the housing in such a way that the assembly may be mounted with the switch above the sign or vice-versa, either by having a switch that can be oriented in the housing either way or by using a symmetrical design.

The switch enclosure portion of the housing shall be drilled and tapped for one-half-inch [13 mm] threaded rigid metal conduit at the back and at the bottom, as indicated in the sketch. The back opening shall be fitted with a flush-fitting threaded metal plug.

The sign placard shall be made with 20 gauge sheet steel or aluminum, 5 inches by 7 inches [127 mm x 178 mm] in size. Corners shall be finished round for safety and neat appearance. Instructions on the sign placards shall be black letters or symbols on a white background.

CONSTRUCTION METHODS:

Pedestrian pushbuttons shall be installed on poles as shown in the project plans. All pedestrian pushbuttons shall be located on the sides of the poles shown, closest and parallel to the pedestrian movements served.

Pedestrian pushbuttons shall be installed such that the distance from the pushbutton actuator to the ground shall be 42 inches [1067 mm] and require no more than a 23 inch [584 mm] reach from an acceptable passageway. In instances where the buttons are to be located on the sides of the poles where the terminal compartment would be in the way of the normal mounting height, the housing shall be located just below the terminal compartment, and turned upside down so that the sign is below the housing. The pushbutton shall remain on the appropriate side of the pole.

Where pedestrian pushbuttons are to be mounted on wood poles, it is permissible to mount the pushbuttons with the signs below the button to allow a conduit to enter from the top. On steel poles, the assemblies shall always be mounted with the signs on top. Arrows for sign placards shall be installed such that the arrow indicates the direction served by the button. If arrow designations are shown on the plans, they are based on the pedestrian pushbutton locations as shown in the plans. The City may allow the pushbutton to be located other than as shown in the plans; in these cases, the Contractor shall supply the appropriate signs at no extra cost to the City.

The Contractor shall install the pushbutton as described above and ensure that no water enters the pushbutton through any of the fittings. If water keeps entering the pushbutton after the Contractor has attempted to make the fittings water tight , the Contractor, under the direction of the Engineer, shall drill a small weep hole on the under side of the installed pushbutton to prevent water from accumulating in the pushbutton housing.

MEASUREMENT AND PAYMENT

Pedestrian pushbuttons shall be measured for payment by the number of installed units each, in accordance with the project plans and specifications. The accepted number of pedestrian pushbuttons will be paid for at the contract unit price which shall be full compensation for the pedestrian pushbuttons, sign placards, and incidentals required to complete installation.

Lump Sum Bid: Work performed and materials supplied under this item shall be considered subsidiary to the general bid item “Traffic Signal,” Item No. 650.

BID ITEMS:

Item 613.1: Pedestrian Pushbutton and Sign

ITEM 615
TYPE 170 CONTROLLER AND CABINET

The purpose of this specification is to describe a Type 170 traffic signal controller, its associated cabinet and equipment.

The work shall consist of furnishing the controller, cabinet, associated equipment described herein, mounting equipment, and auxiliary load rack if specified, and mounting in the field. The Contractor will make all field wire terminations inside the cabinet unless otherwise specified. Contractor shall supply the cabinet as specified on the plans.

MATERIALS:

SECTION I - GENERAL REQUIREMENTS

Each controller and cabinet are to be bid as a combined unit, including the controller unit(s), cabinet, load switches, detector units, relays, isolators, auxiliary load racks, etc.

The Contractor shall include all warranties and/or guarantees with respect to materials, parts, workmanship and performance of the product he proposes to supply. The following minimum warranty shall apply:

a) 170 Controller Units - twenty-four (24) months from date of installation.

b) All other equipment shall be warranted for a period of twenty-four (24) months from date of installation.

The warranty shall cover all units, defects, parts, labor, and shipping costs.

The Contractor must supply with each controller operation and maintenance manuals. A minimum of one (1) set shall be supplied with each cabinet. Each cabinet shall be supplied with a cabinet drawing and wiring diagram.

The equipment supplied under these specifications from any manufacturer shall not be construed as endorsement of this equipment by the City of San Antonio. No reference to this purchase will be permitted.

The Contractor will bear all expenses connected with the return of any equipment which the City deems necessary to have returned to the factory for repair during the guarantee period.

The Contractor shall, at the option of the City, supply the City with a standard production model for evaluation by the City prior to approval.

Such requested sample unit shall be provided within two weeks of the written request from the City. The Contractor shall arrange to have the unit transported back to the original sender at no expense to the City.

All equipment required for proper operation of the control equipment, as shown in the project plans, must be provided.

All equipment, including cabinet and all internal components shall conform to the Federal Highway Administration Publication FHWA-IP-78-16, December 1978, and Caltrans' *Traffic Signal Control Equipment Specifications*, dated January 1989, with Addendum 5, dated November, 1992, and with the changes as noted within these specifications. In case of conflicting requirements, the Project Plans or Invitation to Bid shall prevail over these specifications, which shall prevail over the Caltrans specifications, which shall prevail over the FHWA specifications.

All cabinet output file back panels shall be hard-wired with individual copper conductors. Printed circuit boards shall not be used for output file back panels.

SECTION II - 170 CONTROLLER UNIT

All controllers shall be Model 170E Enhanced traffic signal controllers and meet the specifications of Chapters 1 and 2 of the FHWA-IP-78-16, December 1978 publication, and Caltrans' Traffic Signal Control Equipment Specifications, dated January 1989 and with the changes noted herein.

A minimum of 2,048 eight bit words of RAM shall be provided within the controller unit. The address range shall be 0000 to 07FF. Sockets shall be provided for all RAM memory units within the controller.

The controller unit shall be modular in design with the minimum configuration consisting of the CPU, I/O, Regulator, Display, Prom, Modem, and Power Supply. All modules and printed circuit boards shall incorporate plug-in techniques. All modules shall be easily removable from the front of the controller unit, without disassembling the controller chassis.

Ribbon Cables, if used, shall terminate with properly rated and easily repairable connectors. No ribbon

cable shall terminate directly onto a module or printed circuit board. If specialized tools are required to repair the supplied ribbon cable connectors, five (5) sets of such tools shall be provided. The ribbon cables shall be dressed in a neat orderly fashion so as to avoid sharp 90 degree bends.

All batteries provided within the Model l70 controller unit shall be easily disconnected/reconnected, without the use of tools other than a screwdriver, or shall be provided with a switch or inline connector for removing the battery from the circuit. The batteries, switch, or connector, shall be easily accessible by opening of the controller front panel only. The battery provided within the Model 170E controller unit shall consist of sealed rechargeable D cells, rated at 2V, 2.5 AH.

A. PROM Module:

The module shall comply with the details and connections for the Type 170 prom module.

All electrical connections in and out of this module shall be through a printed circuit connector having two rows of 36 independent bifurcated contacts on 0.100-inch [2.5 mm] centers.

The module shall be designed so that the persons inserting or removing the assembly shall not be required to insert hands or fingers within the microprocessor unit housing this assembly. A handle or gripping device protruding no more than 1.25 inches [32 mm] from the front panel shall be attached to the front of the assembly. The front panel shall be connected to ground.

All data inputs and outputs shall be Tri-State Buffered enabling them to drive a load consisting of 10 TTL gates and 200 picofarads. When this module is not being addressed, the data outputs and inputs shall be disabled into a high impedance state and the data I/O lines shall not source or sink more than 100 microamperes. All address inputs shall not load the bus by more than one TTL gate load and 100 picofarads. There shall be provided a positive method to prevent this module from being inserted upside down in the module slot of the controller.

The entire memory address map shall be user definable such that each of the sockets can be addressed independently.

There shall be provided a regulated 5-volt power supply, integral to the module, derived from the 12-volt supply available on the prom module connector. This supply shall provide at a minimum, 500 ma on the prom module.

The prom module shall conform to the State of California specification for Model 412C System memory modules (9/87 Specification with 3/88 Addendum, Method #2, Memory Select #4) with the following memory configuration and addressing:

The module shall be configured with the following:

1 - 27256 PROM	Address Range: 8000-FFFF
1 - 6264 RAM	Address Range: 3000-4FFF
1 - 1225 Zero Power RAM	Address Range: 1000-2FFF
1 - 1225 Zero Power RAM	Address Range: 7010-7FFF

Modules shall be supplied with all RAMs and two PROMs per module (one spare). PROMs shall be supplied blank without software.

The module shall operate and intermate with the 170 controller unit without modification.

B. Connectors:

All wires terminating in connectors, unless otherwise noted, shall be crimped or soldered. Any other type of connectors shall be preapproved by the City of San Antonio prior to submitting the sample unit.

Data or signal carrying connectors shall have redundant areas of contact that will insure l2 milliohms maximum at a rating of 3.0 amps of current. Power carrying connectors shall have redundant areas of contact that will insure l2 milliohms maximum of contact resistance at l5 amps of current.

All connectors shall have an operating temperature range of -55°C to l05°C. Some method of external or internal keying shall be present in every connector.

Every Model 170E unit shall be supplied with two (2) connectors for ACIA communications to the controller. These connectors shall conform to the Electronics Industries Association Standard RS232C. One connector shall be labeled C2 with a read address of 6000 and a write address of 6001. The other connector shall be labeled C20 with a read address of 6002 and a write address of 6003. Each 170 shall be supplied with one C2 cable.

All circuit boards shall be conformal coated with an insulating compound as specified in MIL-I-46058C Amendment 6. The insulating material shall have a fluorescent tracer added to facilitate examination by ultraviolet illumination.

C. Power Supply:

The four internal D.C. voltages shall comply to the following specifications:

(Line voltage 95 Volts AC to l35 Volts AC)

Regulation	Ripple And Noise
+ll.760 to +l2.240	l80MV P-P
-ll.760 to -l2.240	l80MV P-P
+4.900 to +5.l00	75MV P-P
-4.900 to -5.l00	75MV P-P

The regulator card shall provide test points on the front of the card to measure these voltages.

D. Modems:

All units shall be supplied with a modem.

The modem shall provide 2-wire half duplex and 4-wire full duplex communications. It shall be switch-selectable between half duplex and full duplex.

The modem board dimensions, space limitations, and connection pin assignments shall be in accordance with the specifications included in the Federal Highway Administration Publication FHWA-IP-78-16 for the Model 400 Modem.

The modem shall comply with the following requirements:

Data Rate: 300 to 1200 baud modulation.

Modulation: Phase coherent frequency shift keying

Data Format: Asynchronous, serial by bit.

Line and Signal Requirements: Type 3002 voice-grade, unconditioned.

ACIA and Modem Interface: EIA RS-232-C Standards.

Tone Carrier Frequencies (transmit & receive): 1300 Hz (MARK) and 2l00 Hz (SPACE) with plus or minus 1% tolerance. The operating band shall be (½ power,-3dbm) between 1000 Hz and 2400 Hz.

Transmitting Output Signal Level: 0, -2, -4, -6, and -8 dbm (at 1700 Hz) continuous or switch selectable.

Receiver Input Sensitivity: 0 to -40 dbm.

Receiver Bandpass Filter: Shall meet the error rate requirement specified below and shall provide 20 db/Octave, minimum active attenuation for all frequencies outside the operating band.

Clear-to-Send (CTS) Delay: 12 milliseconds (+2 milliseconds).

Receive Line Signal Detect Time: 8 milliseconds (+2 milliseconds) mark frequency.

Receive Line Squelch: 6.5 milliseconds (+1 millisecond) 0 millisecond (OUT).

Soft Carrier (900 Hz) Turn Off Time: 10 milliseconds (+2 milliseconds).

Modem Recovery Time: Capable of receiving data within 22 milliseconds after completion of transmission.

Error Rate: Shall not exceed 1 bit in 100,000 bits, with a signal-to-noise ratio of 16 dbm measured with flat-weight over a 300 to 3000 Hz band.

Transmit Noise: Less than 50 dbm across 600 ohm resistive load within the frequency spectrum of 300 to 3000 Hz at maximum output.

The modem power requirements are as follows:

Input Voltages	Maximum Current Consumption
+12VDC	150 milliamperes
-12VDC	150 milliamperes

Indicators shall be provided on the front of the modem to indicate Carrier Detect, Transmit Data and Receive Data.

The modem shall interface to and operate in the Model 170E controller unit.

The modem shall be FCC registered for use on Bell System telephone lines or have an application pending with the FCC.

SECTION III - DETECTORS

A. General:
The detector unit shall be a Model 222 Loop Detector Sensor Unit. The sensor unit shall produce an output signal when a vehicle passes over or remains over wire loops embedded in the roadway. The method of detection shall be based upon a design that renders the output signal when a metallic mass (vehicle) enters the detection zone causing a change of 0.02% minimum decrease in inductance of the circuit measured at the input terminals of the sensor unit. The detector zone shall include all configurations listed herein.

An open loop shall cause the sensor unit channel to output a signal.

Each sensor unit channel shall be capable of detecting all types of licensed motor vehicles when connected to the loop configurations and lead-in requirements listed herein.

The sensor unit shall comply with all performance requirements when connected to an inductance (loop plus lead-in) from 50 to 700 microhenries with a Q-parameter as low as 5 at the sensor unit operating frequency.

Loop inputs to each channel shall be transformer isolated.

Each individual channel shall have a minimum of 3 switch-selectable operating frequencies.

The sensor unit channel tuning circuits shall be automatic and shall be so designed that drift, caused by environmental changes, or changes in applied power shall not cause an actuation.

B. Mode selection requirements:
Each sensor unit channel shall have Pulse and Presence selectable modes.

Pulse Mode:
In the pulse mode, each new vehicle presence within the detection zone shall initiate a sensor unit channel output pulse of 125 (± 25) ms in duration.

Should a vehicle remain in a portion of the detection zone for a period in excess of 2 seconds, the sensor unit shall channel shall automatically "tune out" the presence of said vehicle. The sensor unit channel shall then be capable of detecting other vehicles entering the

same detection zone. The recovery time between the first vehicle pulse and channel capability to detect another vehicle shall be 3 seconds maximum.

Presence Mode:
In the presence mode, the sensor unit channel shall recover to normal sensitivity within 1 second after termination of vehicle presence in the detection zone regardless of the duration of the presence.

The channel sensitivity settings shall be provided that detect the presence of a vehicle in the detection zone for a specified time period and inductance change(s). The conditions are as follows:

	Minimum Time Duration (min.)	Detector Input Inductance Change
Setting 1	3	0.02% or more
	10	0.60% or more
Setting 2 (OCC)	4	1.00% or more

C. Sensitivity:
Each Sensor Unit channel shall be equipped with a front panel selectable sensitivity setting(s) in presence and pulse modes to accomplish the following under the operational and environmental requirements of these specifications:

1. Each sensor unit channel shall respond to an inductance change of 0.02% while connected to the following City of San Antonio loop configurations:

Single 6x6 loop (4 turns, #14 wire duct, 1 inch [25 mm] minimum depth into street), with a 250 feet [76 m] lead-in cable.

Single 6x6 loop (4 turns, #14 wire duct, 1 inch [25 mm] minimum depth into street), with a 800 feet (244 m] lead-in cable.

Three 6x6 loops (4 turns, #14 wire duct, 1 inch [25 mm] minimum depth into street) connected in series, with a 250 feet [76 m] lead-in cable.

Three 6x6 loops (4 turns, #14 wire duct, 1 inch [25 mm] minimum depth into street) connected in series, with a 800 feet [244 m] lead-in cable.

Single 6x50 monopole loop (2 turns, #14 wire duct, 1" [25 mm] minimum depth into street), with a 250 feet [76 m] lead-in cable.

2. Each sensor unit channel shall respond while in Setting 2 (OCC) to a nominal change in inductance between 0.15% to 0.4% while connected to the above loop configurations. This setting shall not respond to an inductance change of less than 0.1%.

3. The sensor unit channel shall not detect vehicles, moving or stopped, at distances of 3 feet [1 m] or more from any loop perimeter, in all configurations listed above.

All sensitivity settings shall not differ more than 40% from the nominal value chosen.

There shall be a minimum of 7 selectable sensitivity settings including specified sensitivity settings.

D. Response Time:
Response time of the sensor unit channel for the OCC setting shall be less than 20 ms. That is, for any decreased inductive change which exceeds its sensitivity threshold, the channel shall output a ground true logic level within 20 ms. When such change is removed, the output shall become an open circuit within 20 ms.

The sensor unit channels shall begin normal operation within 2 seconds after the application of power or after a reset signal of 15 microseconds.

E. Lightning Protection:
Lightning protection shall be installed within the sensor unit.

The protection shall enable the sensor unit to withstand the discharge of a 10 microfarad capacitor charged to ± 1000 volts directly across the sensor unit input pins with no loop load present.

The protection shall enable the sensor unit to withstand the discharge of a 10 microfarad capacitor charged to ± 2000 volts directly across wither sensor unit input inductance pins or from either side of the sensor unit input inductance pins to equipment ground. The sensor unit input pins shall have a dummy resistive load attached equal to 5.0 ohms.
F. Tracking:
Tracking Rate: The sensor unit shall be capable of compensating or tracking for an environmental change up to 0.001% change in inductance per second.

Tracking Range: The sensor unit shall be capable of normal operation as the input inductance is changed ± 5.0% from the quiescent tuning point regardless of the internal circuit drift.

The sensor unit shall be capable of normal operation as the input resistance is changed ±0.5% from the quiescent tuning point regardless of the internal circuit drift.

G. Environmental Integrity:
The operation of the sensor shall not be affected by changes in the inductance and/or capacitance of the loop caused by environmental changes with the rate of temperature change not exceeding 1 °C per three minutes. The opening or closing of the controller cabinet door with a temperature differential of up to 18 °C between the inside and outside air shall not affect the proper operation of the sensor unit.

SECTION IV - ISOLATORS
DC Isolators shall be Model 242 and shall meet FHWA-IP-78-16 specifications chapter 7. See Section VI L for quantities to be supplied with particular cabinets.

AC Isolators shall be Model 252, supplied as specified in Section VI L, and placed in input file slot I11, with

marker strip labeled "DOOR ALARM" in each Type 332 and 336 cabinet.

SECTION V - LOAD SWITCHES

All load switches shall be solid-state switches and shall turn on and off within plus or minus 5 degrees of the zero voltage point of the AC sinusoidal line. Load switch can be type 200 or 202 in accordance with the specification of FHWA-IP-78-l6.

SECTION VI - CONTROLLER CABINETS

This specification defines the cabinets to be used with the Model 170E controller units. This specification replaces Chapter 11 of Federal Highway Administration Publication FHWA-IP-78-16, Type 170 Traffic Signal Controller System, hereafter referred to as TSCES.

Details of alternative designs must be submitted to the Traffic Signal Engineer for approval prior to fabrication.

A. General Cabinet Construction:
All cabinets shall be rainproof. The cabinet top shall be "crowned" or slanted to prevent standing water.

The cabinet and doors shall be fabricated of 0.125-inch [3 mm] minimum thickness aluminum. All exterior seams for cabinet and doors shall be continuously welded. All exterior welds shall be smooth. All edges shall be filed to a radius of 0.03125 inch [0.794 mm] minimum.

Cabinets shall conform to the requirements of ASTM Designation: B 209 for 5052-H32 aluminum sheet.

Welding shall be done by the gas metal arc (Mig) or gas tungsten arc (Tig) process using bare aluminum welding electrodes. Electrodes shall conform to the requirements of the American Welding Society (AWS) A5.10 for ER5356 aluminum alloy bare welding electrodes.

Procedures, welders and welding operators for welding on aluminum shall be qualified in accordance with the requirements of AWS B3.0, "Welding Procedure and Performance Qualification," and to the practices recommended in AWS C5.6.

The surfaces of each aluminum cabinet shall be the original cast-like finish or fabricated finish. Any variations of finish shall be preapproved in writing by the City. Each cabinet shall be equipped with an electric fan with ball or roller bearings and a capacity of at least 100 cubic feet [3 cubic meters] of free air delivery per minute.

The fan shall be mounted within the cabinet and vented out between the top of the cabinet and the front door.

The fan shall be thermostatically controlled and shall be manually adjustable to turn on between 33 °C and 65 °C with a differential of not more than 6 °C between automatic turn on and turn off. The cabinet fan circuit shall be protected at 125 percent of the ampacity of the fan motor.

Intake (including filter) and exhaust areas shall pass a minimum of 60 cubic feet [2 cubic meters] of air per minute.

Each cabinet shall be provided with louvered vents in the front door with a removable and reusable metal air filter. The filter shall cover the vents and shall be held firmly in place with bottom and side brackets and a spring-loaded upper clamp.

The bottom filter bracket shall be formed into a waterproof sump with drain holes to the outside. The louvered vents shall be designed and constructed such that a stream of water from a pressure head, such as a Rainbird sprinkler or other type sprinkler, will not enter the cabinet.

All cabinets shall have a police panel. The police door shall provide access to the "Auto-Flash" and "Signals Off" switches. Police Access shall be limited to these two switches. The police panel door shall be equipped with a lock keyed for a master police key.

One key shall be furnished with each cabinet for the police lock. Each police key shall have a shaft at least 1.75 inches [44mm] in length.

Type 332, 336, and 337 cabinets shall have single front and rear doors, each equipped with a lock. When each door is closed and latched, the door shall be locked. The latching handles shall have provision for padlocking in the closed position. The operating handle shall be stainless steel with a 7.5-inch [191 mm] handle and a minimum 0.50 inch [13 mm] stainless steel shank. The cabinet door frame shall be double flanged out on all four sides and shall be provided with strikers to hold tension on and form a firm seal between door gasketing and cabinet door frame.

The flange width shall be a minimum of one inch [25 mm], measured from front edge to flange to cabinet outside surface.

Each cabinet will be supplied with locks keyed alike to the standard Corbin #2 core combination. Two keys shall be supplied with each cabinet.

The locks shall have rectangular, spring-loaded bolts. The bolts shall have a 0.281-inch [7 mm] throw and shall be 0.75 inch [19 mm] wide by 0.375 inch (9 mm] thick (dimension tolerance is +0.035 inch [0.89 mm]). The locks shall be left hand on the front door and right hand on the rear door. Keys shall be removable in the locked position only. Locks shall be rigidly mounted with two stainless steel machine screws. In the locked position, the throw shall extend a minimum of 0.25 (+ 0.03) inch [6 mm (+0.76 mm)]. The front portion of the lock shall neither be recessed nor shall it extend more than 0.1875 inch [5 mm] from the face of the door. The locks shall be mounted on the door in such a position that the tumblers are in the upper quadrant.

The latching mechanism shall be a three-point draw roller type. The center catch and pushrods shall be plated. Pushrods shall be turned edgewise at the outward supports and cross section shall be 0.25 inch [6 mm] by 0.75 inch [19 mm], minimum.

Supports shall be 0.105 inch [3 mm] steel, minimum. Rollers shall have a minimum diameter of 0.875 inch [22 mm] and shall be equipped with ball bearings and nylon wheels. The center catch shall be fabricated of 0.1875-inch [5 mm] plated steel, minimum.

Each door shall be equipped with two bolt hinges, minimum 3.5 inches [89 mm] long. Each hinge shall have a fixed pin. All doors shall be provided with catches to hold the door open at both 90 degrees and 180 degrees, plus or minus ten degrees. The catches shall be 0.375 inch [10 mm] diameter minimum, plated steel rods. Door latches, in latched position, shall not come in contact with cabinet surface or flange lip. The catches shall be capable of holding the door open at 90 degrees in a 60 MPH [96.54 kph] wind at an angle perpendicular to the plane of the door.

On all cabinets, door hinge pins and bolts shall be made of stainless steel. Door hinges shall be made of aluminum. The hinges shall be bolted to the cabinet and may be welded to the door. The hinge pins and bolts shall be covered by the door edge and shall not be accessible when door is closed. Hinge pins will be welded at each end to form a cap and welds filed or ground smooth.

Type 332 cabinets shall be provided with two lifting eyes to be used when placing the cabinet on the foundation. Each eye attached to the cabinet shall have a minimum diameter of 0.75 inch [19 mm] and shall be capable of supporting the cabinet.

Gasketing shall be provided on all door openings and shall be dust-tight. Gaskets shall be 0.25 inch [6 mm] minimum thickness closed cell neoprene and shall be permanently bonded to the metal. The mating surface of the gasketing shall be covered with a silicone lubricant to prevent sticking to the mating surface.

B. Power Supply:
A power supply shall be provided in the cabinet for all equipment installed in the cabinet except the 170 Controller unit, the Model 210 Monitor and the Models 242 and 252 Isolators.

All Power Supply Assemblies (PDA) for 8-phase cabinets shall meet Caltrans' Traffic Singal Control Equipment Specifications for PDA #2, dated January 1989 or latest revision.

The power supply shall be ferro-resonant design having no active components and shall conform to the following requirements:

Line Regulation: Two percent from 95 to 135 VAC at 60 Hz, plus an additional 1.6 percent for each additional one percent frequency change.

Load Regulation: Five percent from one ampere to five amperes with a maximum temperature rise of 30°C above ambient.

Design Voltage: +24 (+0.5) VDC at full load and 30 °C with 115 VAC input line after 0.5 hour warm-up.

Full Load Current: Five amperes, minimum.

Ripple Noise: Two volts peak-to-peak and 500 millivolts rms at full load.

Line Voltage: 95 to 135 VAC.

Efficiency: 60 percent, minimum.

Minimum Voltage: 22.8 VDC.

The power supply front panel shall include:

All fuses or circuit breakers.

Pilot lamp.

Test points or meter for monitoring output voltage.

The power supply, including terminals, shall be protected to prevent accidental contact with energized parts.

Wiring for 120 VAC power input to power supply shall be terminated on terminal strips or soldered. AC plugs will not be acceptable.

The power supply cage and transformer shall be securely braced with nylon strapping to minimize damage in transit.

C. Flash Transfer Relay:
The Flash Relays shall conform to the requirements of these specifications.

A leakage resistor, which will permit 3 to 8 volts to be applied to the relay coil, shall be installed across the terminals of each relay socket to overcome the residual magnetism.

The flash transfer relay shall transfer field outputs from switchpack output to flash control. Transfer of the flash transfer relay circuit to flash control shall not interrupt the operation of the controller unit.

The coils of the flash transfer relays shall be energized only when the signals are in flashing operation and the police panel "ON/OFF" switch is in the "ON" position.

D. Equipment Removal:
The following equipment shall be completely removable from the cabinet without removing any other equipment and using only a screwdriver:

a. Power Supply

b. Power Distribution Assembly

c. Input File

d. Output File

E. Miscellaneous:

All fuses, circuit breakers, switches, (except police panel switches and fan fuse) and indicators shall be readily visible and accessible when the front door is open.

All equipment in the cabinet shall be clearly and permanently labeled. The marker strips shall be made of a material that can be easily and legibly written on using a pencil or ball-point pen. Marker strips shall be located immediately below the item they are to identify and must be clearly visible with the items installed. Glossy marker strips are not acceptable because ink tends to bubble and smear. Resistor/Capacitor transient suppression shall be provided at the relay socket (across relay coils) and in the fan circuit.

F. Cabinet Wiring Diagram:
One set of nonfading (comparable to Xerox 2080) readable cabinet wiring diagrams shall be supplied with each cabinet. The diagram shall be nonproprietary. They shall identify all circuits in such a manner as to be readily interpreted. The cabinet drawing shall show the component layout in an elevation view as viewed from the rear of the cabinet with the left and right cabinet walls shown in their relative positions. The diagrams shall be placed in a heavy duty side opening clear plastic pouch and attached to the front cabinet door. The pouch shall be of such design and material that it provides adequate storage and access to the wiring diagram, and shall be constructed of a material which will not react with or stick to xerographic plastic toners used in copy machines.

Detailed equipment layout scale drawings and wiring diagrams of all equipment installed in the cabinet shall be submitted to the Traffic Engineer for approval prior to production. Review by the City does not lessen the contractor's responsibility to meet the specifications.

G. Cabinet Light:
Each cabinet shall be equipped with a fluorescent lighting fixture mounted inside the top front of the cabinet. The fixture shall have an 8 watt lamp AT5-CW, operated from a normal power factor, U.L. listed ballast. The lamp shall be shaded to diffuse the light. A door switch shall be installed to turn the cabinet light on when the front door is opened. The door switch shall be on a separate circuit by itself, and used only to turn on the light and operate the door alarm.

On the Type 332 and 336 cabinets, additional wiring shall be provided from the load (normally open) side of the light switch to Input File location I11D, and run AC- to Input File location I11E for the door alarm circuit.

H. Conductors:
Conductors used in cabinet wiring shall terminate with properly sized spring-spade type terminals or shall be soldered to a through-panel solder lug on the rear side of the terminal block. All crimp-style connectors shall be applied with a power tool which prevents opening of the handles until the crimp is completed.

Conductors in the controller cabinet between the service terminals and the signal bus breakers including the chassis ground conductor to Power Distribution Assembly shall be No. 8, or larger.

All conductors used in controller cabinet wiring shall be No. 22, or larger, with a minimum of 19 copper strands. Conductors shall conform to Military Specification: MIL-W-16878D, Type B or better. The insulation shall have a minimum thickness of 10 mils and shall be nylon jacketed polyvinyl chloride except that Conductors No. 14 and larger may have Type THHN insulation, and shall be stranded with a minimum of seven copper strands.

All conductors, except those which can be readily traced, shall be labeled. Labels attached to each of the conductors shall identify the destination of the other end of the conductor.

All conductors used in controller cabinet wiring shall conform to the following color-code requirements:

a. The grounded conductors of AC circuits shall be identified by a continuous white or gray color.

b. The equipment grounding conductors shall be identified by a solid green color or by a continuous green color with one or more yellow stripes.

c. The DC logic ground conductors shall be identified by a solid white color with a colored (except green) stripe.

d. The ungrounded conductors shall be identified by any color not specified above.

All cabinet wiring harnesses shall be neat, firm and routed to minimize crosstalk and electrical interference. Printed circuit motherboards may be used to eliminate or reduce cabinet wiring.

a. Wiring containing AC shall be routed and bundled separately or shielded separately from all logic voltage control circuits.

b. Cabling shall be routed to prevent conductors from being in contact with metal edges.

All conductors, terminals or parts, which could be hazardous to maintenance personnel, shall be protected with suitable insulating material.

Within the cabinet wiring, the DC logic ground and equipment ground shall be electrically isolated from the AC grounded conductor and each other by 500 megohms when tested at 250 VDC, with the power line surge protector disconnected.

Conductors from Connector C to the input file shall be of sufficient length to allow any conductor to be connected to any detector output terminal (Positions S, F, W). The AC- copper terminal bus shall not be grounded to the cabinet or connected to the logic ground and shall provide a minimum of 10 terminals for connection to field conductors. Nylon screws with a

minimum diameter of 0.25 inches [6 mm] shall be used for securing the bus to the service panel.

An equipment grounding (earth ground) bus shall be provided in each cabinet. The bus shall be copper and grounded to the cabinet.

The output common of the cabinet power supply shall be connected to the DC logic ground bus using a No. 14, or larger, stranded copper wire.

The DC ground bus shall be located on the input panel.

A No. 8, or larger, copper conductor shall be connected between equipment ground bus and rack rails.

Terminals for the signal wires shall be fitted with 90 degree lugs for #14 AWG wire. Lugs shall be the type that the end of the field wire slips into and is held in place with a compression screw on the wire. (Blackburn #L35 or equivalent)

Each loop detector lead-in, from the field terminals in the cabinet to the sensor unit rack connector shall be a cable UL Type 2092 or better. The stranded tinned copper drain wire shall be connected to a terminal on the input file terminal block. This input terminal shall be connected to the equipment grounding bus through a single conductor.

Each cabinet shall be provided with one harness, terminated at one end with standard C-2 connector plugs, at the other end to a terminal strip, and four feet in length. The harness for the C-2 connector shall contain conductors for the AUDIO IN and AUDIO OUT pairs. Harness shall be terminated at a terminal strip placed near the bottom of the cabinet, and each AUDIO IN and AUDIO OUT position on the terminal strip shall be protected with an EDCO Model SRA-64C (18 VAC) or approved equal. Harness conductors shall be clearly labeled at the terminal strip.

I. Surge Protection:
All cabinets shall be provided with an EDCO Model # SHA-1210 or approved equal. Cabinet shall be wired so filtered AC+ shall be supplied to the 170 unit receptacles (2), cabinet power supply, and conflict monitor only.

Surge protection shall be provided for all cabinet power.

All signal output lines shall be protected by a MOV installed at the field wiring terminal block, between the terminal and earth ground. The MOV shall be Type V150LA20.

J. Conflict Monitor:
All cabinets shall be supplied with one or more signal conflict monitors Model 210 that meet specification FHWA-IP-78-16 Chapter 3.

The monitor shall include the following features:

a. An A.C. power indicator light mounted on the front panel.

b. A 24 VDC failure indicator shall be provided. Indicator shall latch in the lit mode upon occurrence of a 24 VDC failure. Once tripped, the 24 VDC monitoring circuits and indicator shall only be resettable by manual reset.

c. The monitor shall not use the 24VDC power supply being sensed to run any of it's internal circuitry.

K. Heavy Duty Relays:
This specification defines the Model 430 heavy duty relays to be used with the Model 170E controller unit.

This specification replaces chapter 17 of Federal Highway Administration Publication FHWA-IP-78-16, Type 170 Traffic Signal Controller System:

1. Heavy duty relays shall be the electromechanical type and shall be designed for continuous duty at 95 to 135 VAC.

2. Each relay shall mate with the eight-pin Jones-type socket as shown on the plans and shall be enclosed in a removable, clear plastic cover.

3. The manufacturer's name and part number, and electrical rating, shall be provided on the cover. They shall be permanent, durable and readily visible when the relay is mounted in its socket.

4. Each relay shall be provided with double-pole, double-throw contacts. Contact points shall be of fine silver, silver alloy or superior alternative material. Contact points and contact arms shall be capable of switching at 20 amperes tungsten load per contact, and 120 VAC once every two seconds with a 50 percent duty cycle, for at least 250,000 operations, without contact welding or excessive burning, pitting or cavitation.

5. The relay coil shall have a power consumption of 10 volt-amperes or less.

6. Each relay shall withstand a potential of 1,500 volts at 60 hertz between insulated parts, and between current carrying parts and non-current carrying parts.

7. Each relay shall have a one-cycle surge rating of 175 amperes RMS.

L. Supply Quantity:
All cabinets shall be supplied with all necessary equipment for proper operation, including the plug-in items listed in the following table, in all cases, regardless of the intended operation.

CABINET TYPE	303	332	336	337
Load Switches	6	12	12	6
DC Isolators	2	3	3	2
Detectors	4	14	12	4
Conflict Monitors	1	2	2	1

AC Isolators	1	1	1	1

M. Output Files:

There shall be eight capacitive dummy loads mounted to a terminal block on the rear of the swing-down back panel. One side of each dummy load shall be tied to AC-. Four of the dummy loads shall be connected at the factory to the center (yellow) output of the load switches assigned to ped signals for Phases 2, 4, 6, and 8.

The P20 connector and cable assembly for monitoring the red outputs of all load switches shall be provided and mounted to the swing-down back panel, for future use.

Auxiliary output files shall be provided in each Type 332 cabinet. Auxiliary output files shall be supplied in Type 336 cabinets if specified (adequate rack length shall be provided in all 336 cabinets for an aux file in case the City retrofits one at a later date). The file shall accommodate six load switches and two flash relays. The file shall be connected via a cable to the C6 connector on the rear of the standard 12-position output file. Four dummy capacitive loads shall be provided on a terminal block for selective jumping to the outputs of the load switches. The red and yellow signal circuits of switch packs 13, 14, 16, and 17 shall be available at a Molex type 1375 receptacle which shall intermate with a Molex type 1375 plug to allow flash programming. A plug connector, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Plugs shall be readily accessible without the removal of any other equipment. Plug pins shall be crimped and soldered.

SECTION VII - TYPE 332 CABINET

A. Rack Assembly:
A standard EIA 19-inch [483 mm] rack cage shall be installed inside the cabinet for mounting the controller unit, input file power supply, output file and power distribution assembly. The EIA rack portion of the cage shall consist of two pairs of 53-inch [1346 mm] minimum usable, continuous, adjustable equipment mounting angles of 0.1345 inch [3 mm] nominal thickness plated steel tapped with 10-32 threads with EIA universal spacing. The angles shall comply with Standard EIA RS-310-B and shall be supported top and bottom by welded support angles to form a cage. Clearance between rails for mounting assemblies must be 17.75 inches [451 mm].

Two plated supporting angles extending from the front to the back rails shall be supplied to support the controller unit. The angles shall be designed to support a minimum of 50 pounds [22.7 kilogram] each. The horizontal side of each angle shall be mounted 17.5 inches [445 mm] from the top of the rack and shall be adjustable vertically.

The cabinet shall have supporting angles (railing) on either side level with the bottom edge of the door opening to provide horizontal support for the cage.

The cage shall be vertically attached to each side of the cabinet at four points, two at the top and two at the bottom of the rails.

A minimum of 10.5 inches [267 mm] of EIA rack height and 20 inches [508 mm] of depth (18 inches [457 mm] behind and two inches [50 mm] in front of the mounting ears) shall be provided for the Model 170E controller unit.

A 2-inch [50 mm] tall drawer shall be rack-mounted in each Type 332 cabinet. The drawer shall be provided with a hinged top cover and shall be capable of supporting 50 pounds [22.68 kg] in the extended position.

B. Input File:
The input file shall utilize 5.25 inches [133 mm] of rack height. The input file shall intermate with and support 14 two-channel loop detector units.

The input file shall provide card guides (top and bottom) and a 22-pin single-readout, edge connector centered vertically for each detector. The input file shall allow air circulation through the top and bottom.

Pins D, E, F, J, K, L, and W on each edge connector slot shall be terminated on their associated terminal block mounted on the rear of their input file. Pins F and W for each slot shall terminate on the terminal blocks mounted on the rear of the input file and will connect to the proper controller unit inputs in the Connector C1S wiring harness. Common grounding of output emitters will be permitted and common grounding conductor brought out to TB15, Terminal 4 (CTR DC GND).

The edge connectors shall be double-sided connectors with the numbered side of each pin shorted to its respective lettered side internally.

The card guide shall begin 1.0 (+0.5) inch [25 mm +12 mm] back from the front face of the file.

The input file shall be provided with marker strips to identify isolators and detectors in the file as described in Section VI E.

C. Power Distribution Assembly:
The power distribution assembly shall be furnished and mounted on the EIA 19-inch [483 mm] rack utilizing no more than seven inches [178 mm] of rack height. All equipment shall be readily accessible for ease of replacement. The depth of the assembly shall not exceed 10 inches [254 mm] from the front cabinet rails including terminal blocks.

The following equipment shall be provided with the power distribution assembly:

2 - Equipment duplex receptacles (one on the front panel, and another on the back panel readily accessible from back door)

1 - Controller unit duplex receptacle

1 - Main circuit breaker

1 - Four-pole single bus circuit breaker

1 - Two-pole flash bus circuit breaker

1 - Equipment circuit breaker

1 - Mercury Contactor

1 - Auto/Flash Switch

1 - Flash Relay and socket

2 - Flasher Unit sockets

2 - Model 204 Flasher Units

1 - Flash Indicator light

Terminal Blocks

The main circuit breaker shall be rated for 50 amperes at 120 VAC. The circuit breakers for the equipment receptacles and signal bus shall be rated for 15 amperes at 120 VAC. The flash bus circuit shall be rated for 20 amperes at 120 VAC. Rating of breakers shall be shown on face of breaker or handle. Breaker function shall be labeled below breakers on front panel.

Equipment Receptacles shall be NEMA 5-15R duplex type. The Equipment Receptacles shall have ground-fault circuit interruption as defined in the National Electrical Code. Circuit interruption shall occur on six milliamperes of ground-fault current and shall not occur on less than four milliamperes of ground-fault current.

An "Auto/Flash" switch shall be provided which, when placed in "Flash" position (down), shall energize the Mercury Contactor (MC) Coil. When the switch is placed in the "Auto" position (up) the switch packs shall control the signal indications. The switch shall be a single-pole single-throw toggle switch rated for 15 amperes at 120 VAC.

A lamp labeled "Flash Operation" shall be provided on the front panel of the assembly. The lamp shall be driven by the Flasher Unit Output through Transfer Relay Circuit No. 1.

The Controller Unit Receptacle shall be a hospital grade NEMA 5-15R mounted on the back panel of the assembly. AC+ to the 170 unit receptacle shall be from the filtered outputs of the SHA-1210 surge protector.

Terminal Blocks shall be provided and mounted on the back panel of the assembly. The blocks shall be of type specified for signal field wire terminal blocks. All conductors from the power distribution assembly routed to the cabinet wiring shall be connected to the terminal block on the common side, except for the AC power conductor between the service terminal block and main circuit breaker.

All internal conductors terminating at the blocks shall be connected to the other side of the blocks. Terminal position assignments shall be as shown on Plan Sheet No. SA170-4, Model 332 T1 and T2 Terminal Block Assignment Detail, modified as follows:

> "Add two No. 14 conductors between the back equipment duplex receptacle and the PDA Terminal Blocks (AC+ to T1, Terminal 10; AC- to T2 Terminal 1.)"

The Flash Relays shall conform to the provisions for "Heavy Duty Relays, Model 430."

A leakage resistor, which will permit three to eight volts to be applied to the relay coil, shall be installed across the terminals of each relay socket to overcome the residual magnetism.

D. Output File:
Card guides shall be provided to support the switch packs and the monitor unit.

The output file shall utilize 10.5 inches [267 mm] of rack height and shall be supplied with 12 Model 200 Switch Packs. Four Model 430 Flash Transfer Relays and one Model 210 Monitor Unit shall be furnished with each output file. The depth of the assembly including terminal blocks and relays shall not exceed 14.5 inches [368 mm] from the front cabinet rails.

The output file shall be provided with marker strips to identify switch packs when mounted in the file, as specified in Section VI.

Switch pack connectors, monitor unit connectors, flash transfer relay sockets and flash programming connectors shall be accessible from the back of the output file without the use of tools.

Three field wire terminal blocks shall be mounted vertically on the back of the assembly. The terminal blocks shall be the 12-terminal type.

The controller unit outputs to the output file shall be connected through Connector C4.

The red and yellow signal circuits of all switch packs assigned to vehicle signals for phases 1 through 8 shall be available at a Molex Type 1375 Receptacle which shall intermate with a Molex Type 1375 plug to allow flash programming. A plug connector, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Connectors shall be readily accessible without the removal of any other equipment. Plug pins shall be crimped and soldered.

The monitor connector shall be rigidly supported printed circuit board edge connector, having two rows of 28/56 independent double readout bifurcated contacts on 0.156 inch [4 mm] centers. The connector shall terminate with the Model 210 Monitor Unit.

It shall be possible to remove the monitoring device without causing the intersection to go into flashing operation. The cabinet shall be wired so that with front cabinet door closed and with the monitor unit removed,

the intersection shall go into flashing operation. The cabinet shall contain a conspicuous warning against operation with the monitor unit removed.

The monitor unit connector shall be wired in accordance with the pin assignment shown on the plans.

Output File Option: The monitor unit compartment including the housed Model 210 Monitor Unit, exclusive of handle, shall extend no farther than 1.25 inches [32 mm] in front of the 19-inch [483 mm] rack front surface. The switch pack socket connector front surface shall be no more than 8.5 inches [216 mm] in depth from the front surface of the output file. (This option allows use of a common motherboard for switch packs and monitor unit).

E. Side Panels:
Two panels shall be provided and mounted on the EIA rack parallel to the cabinet sides.

In viewing from the back door, the left side panel shall be designated as the "Input Panel" and the right side panel shall be designated as the "Service Panel".

All input field terminal blocks for detector field cables and other input conductors, except service conductors, shall be mounted on the "input panel". The "input panel" shall be wired per CALTRANS's August 1983 specification.

F. Terminal Blocks:
Terminal blocks shall be provided for terminating field conductors. They shall be readily accessible through the cabinet rear door and shall be rated for 20 amperes at 600 volts RMS, minimum.

The terminal blocks for detector field conductors, auxiliary field wires and control wires shall be the barrier type and shall be provided with 8-32 by 5/16 inch [8 mm] minimum nickel plated brass binder head screws and nickel plated brass inserts.

The terminal blocks for field wires to the signal indications, power distribution assembly and the required unused position shall be the barrier type and shall be provided with 10-32 by 5/16 inch [8 mm] nickel plated brass binder head screws and nickel plated brass inserts.

The terminal blocks for the input file and power supply shall be the barrier type and shall be provided with 8-32 by 5/16 inch [8 mm] nickel plated brass binder head screws and nickel plated brass inserts.

The terminals of the power line service terminal block shall be labeled "L1" and "AC-", and shall be covered with a clear insulating material to prevent inadvertent contact. Terminating lugs large enough to accommodate No. 2 conductors shall be furnished for the service terminal block. The terminal block shall be rated for 50 amperes at 600 volts, minimum.

G. Connectors:

Connector C1P shall contain 104 pin contacts and shall intermate with connector C1S mounted on the controller unit chassis. Corner guide pins for connector C1P shall be stainless steel and shall be 0.097 inches [2 mm] in length. Corner guide socket assemblies shall be stainless steel and shall be 0.625 inches [16 mm] in length.

Connector C4 shall contain 37 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The Plug Connector C4P shall be mounted on the output file.

Connector C5 shall contain 24 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The Plug Connector C5P shall be mounted on the input file.

Connector blocks for Connector C1 pin and socket connectors shall be constructed of diallylphathalate or better. Contacts shall be secured in the blocks with springs of stainless steel.

SECTION VIII - TYPE 337 CABINET

This section defines the minimum detailed requirements for a four-phase post-mounted controller cabinet assembly. The cabinet shall be a weatherproof outdoor type with approximate dimensions of 35 inches x 20 inches x 17 inches [889 mm x 508 mm x 432 mm].

The controller cabinet assembly Model 337 post-top mounted unit shall include all specified wiring, auxiliary devices, slipfitter conforming to the pole size the cabinet is to be mounted to (or with bottom hole and bolt circle conforming to the mounting pedestal specified) and any other necessary mounting hardware.

Cabinets for post-top mounting shall be adequately reinforced in the bottom of the fully-equipped cabinet to withstand a 100 mph [161 kph] wind, and shall have less than 2 inches [50 mm] of deflection at the top when a 100 pound [445 N) force is applied horizontally at the top of the cabinet on any of the four planes of cabinet faces. Adaptors will be allowed if they meet the above requirements for strength and stiffness and if they effectively seal the floor of the cabinet against dust and moisture. Reinforcing which consists of two 4.5 inch x 3/4 inch [114 mm x 19 mm] support channels, opened face down, welded across the bottom front and rear of the cabinet, and extending from side to side, in addition to a square slipfitter mounting support bracket which is installed and welded to the two support channels, will be considered to meet these requirements. Any other bottom support configuration must be approved by the City.

Rail shall be provided, both front and rear, as an integral part of the cabinet. Rails shall extend the full height of the cabinet and shall conform to dimensional requirements of Standard EIA RS-310-C, except equipment mounting holes shall be provided with 10-32

threads and shall be located to secure equipment provided.

Two plated supporting angles shall be supplied to support the controller unit. The angle shall be designed to support a minimum of 50 pounds [22.68 kilograms] each. The horizontal side of each angle shall be a minimum of 3 [76 mm] inches and the length a minimum of 11 inches [279 mm].

A. Rack Assembly:
The rack assembly shall be self-supporting and shall allow a free space beneath the lowest horizontal surface and between the side panels of 17 inches [432 mm] wide by 16 inches [406 mm] deep by 9 inches [229 mm] high with both cabinet doors closed.

The assembly shall be equipped with mounting "ears" to allow mounting in standard EIA rails. Overall width of the assembly shall conform to Standard EIA RS-310-C.

The rack assembly shall be fabricated and mounted according to the dimensions shown on the plans.

The rack assembly shall provide a space which shall intermate with and support a Model 204 flasher. The flasher shall be wired so as to have its load balanced among switch packs 1 through 4.

An Auto-Flash switch shall be provided for the use of Maintenance Personnel.

A Maintenance Interlock Switch (MIS), MFG. Cherry P/N-50KX Series E-23, shall be provided to supply emergency power to the flasher and flash transfer relays in the event that the Power Distribution Assembly is removed. This shall be accomplished in a manner which prevents the application of emergency power unless the maintenance Auto-Flash switch is in the Flash position. Emergency power to the flasher and transfer relays shall be independently fused.

The rack assembly shall provide a receptacle which shall intermate with and support the Power Distribution Assembly (PDA). The receptacle shall be equipped with a connector (BEAU SG 5413 ABT or equal). Dimensions for the receptacle and location and pin assignments for the connector shall be as shown on the plans.

Means shall be provided to secure the PDA.

The front face of all plug-in assemblies shall be flush with the front face of the rack assembly. The sole exception shall be the Flash Relay, which may be mounted with its socket on the same plane as the flash transfer relay sockets.

The front face of the rack assembly may be inset from the EIA rails a maximum of l/2-inch [13 mm].

The rack assembly depth shall not exceed 13 inches [330 mm] from the front surface of the front EIA rails.

The assembly shall allow air circulation from bottom to top.

Field wire terminal blocks and bus bars shall be mounted on the back panel of the assembly. The three signal output terminal blocks shall be mounted vertically and shall be the six position type.

The rear panel shall be hinged to allow it to swing down and provide access to terminals, relays and connections as detailed elsewhere in these specifications.

The rack assembly shall provide for an Input File subassembly and an Output File subassembly, both of which shall be integral to the Rack Assembly.

B. Input File:
The Input File shall intermate with and support 4 two-channel loop detector units.

The input file shall provide card guides (top and bottom) and a 22-pin single-readout edge-connector centered vertically for each detector unit. Pins D, E, J and K on each edge connector shall be wired to the field terminals to provide for two loop detector channels or one magnetometer channel.

Loops #1 and #2 output collectors and emitters (pins F, H, W and X) for each slot shall terminate on a terminal block mounted on the rear of the input file and shall connect to the proper controller unit inputs in the Connector C1S wiring harness. Common grounding of output emitters will be permitted.

The edge connectors shall be double sided connectors with the numbered side shorted to its respective lettered side internally.

The input shall be provided with marker strips to identify items in the file. Marker strips shall be located immediately above and below the item they are to identify.

C. Power Distribution Assembly:
The power distribution assembly shall be furnished and mounted on the EIA 19 inch [48 mm] rack Assembly. Maximum dimensions are 12.05 inches [308 mm] wide by 3.90 inches [99 mm] high by 7.375 inches [187 mm] deep.

The PDA shall be equipped with a connector to intermate with its associated connector in the Rack Assembly.

The following equipment shall be provided with the power distribution assembly:

1 - Main circuit breaker

1 - Signal circuit breaker

1 - Flash circuit breaker

1 - Equipment circuit breaker

1 - 24VDC Power Supply

1 - Power relay and socket

1 - Auto/Flash switch (Police)

1 - Signals-Off switch

1 - Power indicator labeled "24VDC PWR"

1 - Flash indicator units

2 - Test points

2 - Power Supply fuses (AC and DC)

All circuit breakers shall be rated for 120 volts AC with the following ratings:

Main and Signals	30 amperes
Flasher	20 amperes
Equipment	15 amperes

D. Output File:
Card guides shall be provided to support the switch packs and monitor unit.

The Output file shall be capable of containing six Model 200 switch packs, three Model 430 flash transfer relays, one Model 210 monitor unit and one Flash Relay.

The Output File shall be provided with marker strips to identify items in the file. Marker strips shall be located immediately below the item they are to identify, as described in Section VI E.

Switch pack, flash transfer relay and monitor unit sockets shall be accessible from the back of the file without the use of tools.

The controller unit outputs to the Output File shall be connected through Connector C4.

The red and yellow signal circuits of all switch packs shall be available at a Molex Type 1375 receptacle which shall intermate with a Molex Type 1375 plug to allow flash programming. Plug connectors, with programming jumpers, shall be furnished for each circuit to allow red, yellow or pedestrian flash programming. Requirements are: 4 red, 3 yellow and 3 pedestrian. Connectors shall be readily accessible without the removal of any other equipment. The monitor unit connector shall be a rigidly supported printed circuit board edge connector, having two rows of 28/56 independent double readout bifurcated contacts on 0.156 inch (3.96mm) centers. The connector shall intermate with the monitor unit.

It shall be possible to remove the monitor unit without causing the intersection to go in flashing operation. The cabinet shall be wired so that with the front door closed and the monitor removed, the intersection shall go into flashing operation. The cabinet shall contain a conspicuous warning against operation with the monitor unit removed.

E. Outlet Panel:
An Outlet Panel shall be provided at a convenient location. It shall contain the following:

1 – Equipment Receptacle

1 – Controller Receptacle

1 – Terminal Block (TB1)

Equipment Receptacles shall be NEMA 5-15R duplex type. The Equipment Receptacles shall have ground-fault circuit interruption as defined in the National Electrical Code. Circuit interruption shall occur on six milliamperes of ground-fault current and shall not occur on less than four milliamperes of ground-fault current. The Controller Unit Receptacle shall be a hospital grade NEMA 5-15R mounted on the back panel of the assembly.

TB1 shall be a 6-position double-row terminal block.

F. Connectors:
Connector C1P shall contain 104 pin contacts and shall intermate with Connector C1S mounted on the controller unit chassis. Corner guide pins for Connector C1P shall be stainless steel and shall be 1.097 inches [28 mm] in length. Corner guide socket assemblies shall be stainless steel and shall be 0.625 inch [16 mm] in length.

Connector C4 shall contain 24 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The Plug Connector C4P shall be mounted on the Rack Assembly.

Connector blocks for Connector C1 pin and socket connectors shall be constructed of diallylphathalate or better. Contacts shall be secured in the blocks with springs of stainless steel.

SECTION IX - TYPE 303 CABINET

This specification defines the minimum detailed requirements applicable to cabinets and harnesses. The intent of this specification is to set forth the minimum acceptable electrical and mechanical design and requirements within which all equipment must operate satisfactorily and reliably, and the means by which the equipment shall be tested to determine whether it shall so operate.

All equipment shall be housed within a rain-proof pole, or post-top mounted cabinet. The cabinet shall be clean-cut in design and appearance and have nominal interior dimensions as follows:

DEPTH: 17 inches [432 mm]

WIDTH: 20 inches [508 mm]

HEIGHT: 36 inches [914 mm]

There shall be minimum clearance of 1 1/2 inches [38 mm] between the inside surface of the front door and the front panel of the Model 170E microcomputer as well as the front panel of modules plugged into the input rack.

The housing shall have a door, opening 33 inches high x 20 inches [838 mm x 508 mm] wide with a 2.5 inches

[64 mm] space between bottom of opening and bottom of cabinet.

All Type 303 cabinets shall be supplied for both pole and pedestal mountings.

Cabinets shall have bolt holes drilled in the back for mating with pole mounting hardware, and shall be supplied with all necessary mounting hardware. Mounts to wood poles shall be accomplished by means of stainless steel straps. Stanless steel plugs for the mounting holes shall be provided.

Cabinets shall be adequately reinforced in the bottom of the fully-equipped cabinet to withstand a 100 mph [161 kph] wind, and shall have less than 2 inches [50 mm] of deflection at the top when a 100 pound (445 N) force is applied horizontally at the top of the cabinet on any of the four planes of cabinet faces. Cabinets shall be drilled for a standard 4 inches slipfitter. The slipfitter and any hardware necessary for pole-mounting shall be provided.

Cabinets shall be supplied with an aluminum electrical box, 8 inches [203 mm] long by 8 inches [203 mm] wide by 6 inches [152 mm] deep drilled to match slipfitter mounting holes in cabinet floor. The box shall be equipped with access cover facing downward. The access cover shall be designed so that when opened, the bottom and one side of the box is accessible, and the cover should hang in the open position. The access cover shall be attached with a full-length piano hinge on one edge and secured with two stainless steel #10 round-head machine screws, with matching threaded holes in the box. The box shall be constructed of 0.125-inch (3.18 mm) thick aluminum. All corners shall be continuously welded or press-broken, and the door shall be gasketed against dust. A 0.125 inch (3.18 mm) drain hole shall be provided at the appropriate location.

A. Rack Assembly:
The cabinet shall be constructed with metal mounting rails running the depth of the cabinet along the lower left and right hand bottom of the cabinet. These rails shall be constructed at a height such that the cabinet rack shall rest on the rail when in its normal position, and shall slide along the rail when being installed or removed.

A rack with standard EIA spacing shall be inside the cabinet for mounting the processor unit and the rack assembly which will contain the rack, switch pack rack, power supply/power distribution panel. The rack shall consist of two pair of full length, 0.1875 inch [5 mm] nominal thickness aluminum angles tapped with 10-32 threads where required a shown in the cabinet drawing, at the end of this specification. Chassis supporting angles extending behind the front rails shall be part of the rack and support the weight of the processor unit. Each chassis supporting angle shall be 10 inches [254 mm] deep and 3 inches [76 mm] deep.

The rack assembly shall be easily removable from the cabinet without use of special tools. By unplugging connector P1, removing the screws securing the rack assembly to the rails, and disconnecting the field wiring, it shall be possible to remove the rack assembly from the cabinet.

B. Input File:
Each detector rack shall utilize 5.25 inches [133 mm] of rack-mounting height.

The detector rack shall provide card guides (top and bottom) and a 22-pin edge-connector on 0.156 inch [4 mm] centers, mounted vertically for each detector. The detector rack shall allow air circulation rough the top and bottom.

Four pins (D,E,J,K) on each detector module edge-connector shall be wired to four field terminals to provide for two loop detector channels.

Loop 1 and 2 output collectors and emitters (pin F,H,W and X) for each slot shall connect to the proper processor unit inputs in the connector C1S wiring harness.

Wiring between the rack and field terminals shall be twisted pair not tightly bundled.

The edge connectors shall be double sided connectors with the numbered side of each pin shorted to its respective lettered side internally.

Output circuit emitters shall have a common junction and be grounded only by connection to C1P, pin 104, DC Input Ground.

A Flasher Assembly Panel shall be located in the left end of the Detector Rack and shall contain the flasher relay.

C. Flasher Relay:
A Type 204 solid state flasher relay to be used for alternate opening and closing connections between the applied power and the lamps required for flashing operation.

The following Table shall determine the inter-connection between the Solid State Flasher and the switchpacks.

Each switchpack shall be assigned to the two Solid State Flasher load circuits as follows:

LOAD CIRCUIT #1	LOAD CIRCUIT #2
S.P. 1	S.P. 4
S.P. 2	S.P. 5
S.P. 3	S.P. 6

D. Maintenance Assembly:
A "Flash" switch, so labeled, shall be provided. This switch when placed in the "On" position shall energize the mercury contactor coil. When this switch is placed in the "Off" position the processor unit shall resume control via the switch pack outputs to the field. The

Flash switch shall be accessible from the Police Panel Door opening.

A "Signal" switch, so labeled shall be provided. This switch, when placed in the "Off" position, shall energize the mercury contactor coil and prevent the flash relay from energizing the flash transfer relays, thereby disconnecting AC to the field terminals. The "Signals" switch shall be accessible from the Police Panel Door opening.

Two 24VDC test points for the cabinet power supply shall be provided.

The 2l0 conflict monitor shall be readily serviceable without special tools.

Card guides shall be provided to guide and support the printed circuit board of the monitor module.

A rigidly supported printed circuit board edge connector, having two rows of 28/56 interdependent bifurcated contacts on 0.156 inch (3.96 mm) centers, shall be provided. The connector shall intermate with the 210 conflict monitor unit.

A 24VDC relay shall be provided to reverse the relay logic of the monitor module. The output of this relay shall be wired in series with a door switch. The relay shall be mounted in the PDA and be readily serviceable. Servicing shall not require any special tools other than a screwdriver. The relay shall be normally open. Monitor pin 25 shall be wired to DC ground and pin 24 shall be wired to one side of this relay with the other side of the relay going to the ferro-resonant supply.

A 110 VAC relay shall be supplied for the activation of the flash relays in the event of loss of AC+ to the load switches.

A spring-loaded door switch, shall be wired in series with the output of the relay described in section and in parallel with the CMU interlock.

Closing of the front cabinet door with the monitor unit removed shall cause the intersection to go into flashing operation. The cabinet shall contain a conspicuous warning against operation with the monitor unit removed.

The stop timing output of the monitor shall go to C1-82 of the processor.

E. Output File:
The load rack shall intermate with Type 200 solid state switch packs. The rack shall be capable of containing six (6) solid state switch packs.

F. Relay Panel:
Relays used for this purpose shall have a clear plastic cover.

All contact points which make, break and carry current to the signal lamps shall be of silver-cadmium, coin silver or superior alternative material. Contacts shall be capable of making, breaking, and carrying a current of 20 amperes 120 volts, without undue pitting. 120 volt AC relay coils shall be used and shall have a power consumption of 10 volt amperes or less and shall be designed for continuous duty.

The transfer relay shall withstand potential of 1500 volts at 60 hertz between insulated parts and between current carrying parts and grounded and non-current carrying parts.

Each flash transfer relay shall have a one cycle surge rating of 175 amperes RMS (247.5 amperes peak).

Each transfer relay shall be unaffected by electrical noise, having a rise time of up to 200 volts per microsecond. Each relay shall be unaffected by the 500 volt power noise transient test when the dv/dt herein specified is not exceeded.

The flash transfer relays shall transfer field signal light circuits (for switch packs 1 thru 6), from the processor unit to flasher and shall permit flashing lights as programmed on the main street or highway and on the cross street or streets. Operation of the flash transfer relay circuit shall not prohibit the operation of the processor, but shall prohibit operation of the field signal light circuits by the processor. The line to the coils of the FTR's shall have a RC suppression device.

The flash transfer relay shall be Midtex, 187-02701A or equal, and shall be provided with a connector (Cinch Jones, type #P-408-53 or equal) and intermate with Cinch Jones, type #S-408-53 or equal, using the following pin definitions:

PIN NUMBER	CIRCUIT
1	Coil
2	Coil
3	NC Ckt #2
4	NC Ckt #2
5	Common Ckt #1
6	Common Ckt #2

A minimum of 4 program block positions shall be provided for flashing operation. The programming plugs shall be provided to alter whether flashing yellow, flashing red, or absence of flash (white) appears on the output field terminals to the signal heads.

Flasher programming shall be provided by the use of a Molex type 1375 receptacle and intermate with a Molex type 1375 plug. Two (2) red, one (1) yellow, and two (2) white programming plugs shall be provided. Flash programming shall be in compliance with the following:

Red programming plugs shall contain three red jumper wires connecting pins 9 and 15, and 3, 7 and 13.

Yellow programming plugs shall contain three yellow jumper wires connecting pins 1 and 7, 3 and 9, 13 and 15.

White programming plugs shall contain two white jumper wires connecting pins 1, and 3, 13 and 15.

G. Power Distribution Assembly:
The main circuit breaker, labeled (Main C.B.) shall be a magnetic breaker, single pole, automatic trip, and trip indicating, rated at 40 amperes at 125VAC.

The auxiliary circuit breaker, labeled (AUX EQ C.B.) shall be a magnetic breaker, signal pole, automatic trip, and trip indicating, rated at 15 amperes at 125 VAC.

The flasher circuit breaker, labeled (FL C.B.), shall be a magnetic breaker, single pole, automatic trip, and trip indicating, rated at 15 amperes at 125 VAC.

The load switch circuit breaker, leveled (LS C.B.), shall be a megnetic breaker, single pole, automatic trip, and trip indicating, rated at 30 amperes at 125 VAC.

A 3 ampere fuse, labeled (24 VDC), shall fuse the 24 VDC output of the ferro-resonant power supply.

A 1 ampere fuse, labeled (24VPS 110VAC), shall fuse the AC input of the ferroresonant power supply.

Four Molex type 1375 receptacles shall be provided and must intermate with a Molex type 1375 plug. The receptacles shall be color coded.

Aux. 1 shall contain all wiring to the maintenance panel switches.

P1 shall contain all wiring that is external to the rack assembly. By removal of the connector the rack assembly may be removed without disconnecting the wiring from terminals with the exception of the field terminals.

P2 shall contain all DC power connections to the rack assembly.

P3 shall contain all AC and power control wiring to the rack assembly components.

A mercury contactor shall be provided and shall be capable of switching a minimum of 30 amperes at 120VAC.

A phone jack, which shall mate with a Switchcraft Model 190 plug, shall be provided for automatic cabinet diagnostic testing. When the plug is inserted, a reset signal will be supplied to the conflict monitor. The source of the reset signal shall be C1-97.

A ground fault interrupter shall be installed and shall be a NEMA 5-15R duplex type. Circuit interruption shall occur between 4 and 6 milliamperes of ground fault current. The ground fault receptacle shall be of the feed-through type.

Terminal blocks shall be so arranged that they shall not upset the the entrance and connections of incoming field conductors. There shall be 5 blocks, each having 12 positions with 10-32 screws. Magnum Electric Corp. 481312-04 or equal.

The AC+ service connection shall be made directly to the main C.B. in the PDA from the power line service terminal. The terminals of the power line service terminal block shall be labeled "L1" and "AC-", and shall be covered with a clear insulating material to prevent inadvertent contact. Terminating lugs large enough to accommodate No. 2 conductors shall be furnished for the service terminal block. The terminal block shall be rated for 50 amperes at 1000 volts, minimum.

SECTION X - TYPE 336 CABINET

This section defines the detailed requirements for an eight-phase controller cabinet to be mounted on a post-top or foundation mount.

The cabinet shall be designed for either post-top or foundation mount. The design must be flexible enough to allow choosing the mounting type at time of installation, and to allow changing the mounting type at any time in the future. For foundation mounting, the cabinet shall be designed with a square opening in the floor of the cabinet as large as possible and still allow easy access to anchor bolts and a good seal with the foundation. For post-top mounting, an adapter shall be used which mates with the anchor bolt holes, in such a way as to provide a dust-proof attachment. The adaptor shall mate with a standard 4 inch [102 mm] slipfitter, and shall be strong enough to meet the stiffness requirements defined below. All cabinets shall be supplied with an adaptor and a 4 inch [102 mm] slipfitter, regardless of the stated application of the cabinet.

All Type 336 cabinets shall be capable of housing an auxiliary output file ("stretch" version), and one shall be supplied and installed when specified.

All Model 336 cabinets shall both a front and a rear door, keyed with a Corbin #2 lock as described previously in the general cabinet specifications.

Cabinets assembled for post-top mounting shall be adequately reinforced in the bottom of the fully-equipped cabinet to withstand a 100 mph [107 kph] wind, and shall have less than 2 inches [50 mm] of deflection at the top when a 100 pound [445 N) force is applied horizontally at the top of the cabinet on any of the four planes of cabinet faces.

The input file shall have 14 slots, and an input panel used, as described for the Type 332 cabinet in Section VIIE.

The output file shall have 12 output slots.

The red and yellow signal circuits of all switch packs assigned to vehicle signals for phases 1 through 8 shall be available at a Molex Type 1375 Receptacle which shall intermate with a Molex Type 1375 plug to allow flash programming. A plug connector, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Connectors shall be readily accessible without the

removal of any other equipment. Plug pins shall be crimped and soldered.

The cabinet shall also include 4 flash relays, and two flashers.

SECTION XI - TESTING AND CERTIFICATION

All controllers and cabinets supplied shall be tested by the manufacturers as complete units as outlined in chapter 1, section 8 in FHWA-IP-78-16 and certification provided to the City of San Antonio that such tests were provided.

The manufacturer shall provide certification that the units supplied under these specifications are not units rejected by some other municipality or state.

CONSTRUCTION METHODS

The Contractor shall have all cabinet equipment (cabinet, controller, load switches, detectors, isolators, etc.) shipped to the Contractor for assembly. Once all devices have been received and assembled by the Contractor, he shall install a copy of the plan sheets relating to that particular intersection, reduced to fit inside the documentation pouch on the door. Once accomplished and the complete assembly is ready for testing, the Contractor shall contact the City Signal Shop at 207-7765 and arrange to schedule for testing and configuration by the City. The City will direct the Contractor as to which day the controller unit(s) can be delivered. When testing is completed, the City will notify the Contractor to pick up the cabinet(s). Upon notification, the Contractor must pick up the cabinet(s) within 2 working days. Any cabinets that are delivered to the City without all the proper devices or documentation within the cabinet, or devices not plugged into the appropriate slots (still boxed, with the exception of the extra conflict monitors) will be rejected until they are corrected. At the option of the City, the Contractor may be required to remove the cabinet(s) from the City Signal Shop. All testing will be scheduled on a first-come-first-served basis, for complete units in compliance with these specifications.

All cabinets shall have a tag wired to the handle indicating the location for which it is intended, and the Contractor's name. Tags shall be of adequate size for lettering to be read easily.

The Contractor shall be responsible for connecting all field wires inside the cabinet according to the project plans, cabinet prints, and the directions of the City. All wires to be terminated in a neat fashion and bundled for a clean appearance. Loop cable wires to have spade connectors.

Once installed on the foundation, the base of the cabinet shall be sealed against water seepage. (Foundation-mounted only)

The door of the cabinet on the controller face side shall be positioned such that the technicians can easily view the signal displays of the intersection.

MEASUREMENT AND PAYMENT

Controllers and cabinets shall be measured for payment as combined units, including software and auxiliary items, per controller cabinet unit, in accordance with the project plans and specifications. The accepted number of units shall be paid for at the contract unit price which shall be full compensation for the items, including installation and transport to and from the City Signal Shop.

BID ITEMS:

Item 615.1: Type 170 Controller and 332 Cabinet

Item 615.2: Type 170 Controller and 303 Cabinet

Item 615.3: Type 170 Controller and 337 Cabinet

Item 615.4: Type 170 Controller and 336 Cabinet

ITEM 617
FLASHER AND CABINET

The purpose of this specification is to describe a two-circuit flasher unit and cabinet to house the unit. The work shall consist of furnishing and installing the flasher and cabinet, labor, and incidentals in accordance with the plans and these specifications.

MATERIALS:

The flasher shall meet the electrical and physical characteristics described in Part 8 of the NEMA Standards Publication TS 1-1976. The two-circuit flasher shall be of solid state design and contain no electromechanical devices.

Voltage range shall be 95 to 135 volts AC. The nominal voltage shall be 120 volts AC. The operating frequency range shall be 60 Hz (± 3.0 Hz).

The flasher shall be designed to operate as specified at any ambient temperature range from -30 °F [-34 °C] to +165 °F [+74 °C].

Flasher shall be Type III, dual circuit rated at 15 amps per circuit.

The flasher shall be so constructed that each component may be readily replaced if needed.

For each flasher assembly supplied, the City shall receive the following documentation:

1. Complete and accurate schematic diagram
2. Complete performance specifications
3. Complete parts list, including vendor names for parts not identified by universal part numbers such as EIA, JEDEC, or RETMA.
4. Pictorial of component layout on circuit board
5. Test report from an approved laboratory certifying that the flasher has been tested and has successfully met all applicable test requirements called for in the NEMA Standard Publication TS 1-1976, and meets the requirements of these specifications.

The manufacturer's guaranty shall be transferred to the City by the Contractor.

The cabinet shall be of sheet aluminum with a minimum thickness of 0.125 inch [3 mm], or cast aluminum alloy. The cabinet shall provide a hinged door equipped with a gasket to insure a weatherproof and dustproof seal when the door is closed and locked.

The door shall be provided with a police lock, installed as an integral part of the door. Two keys shall be provided per cabinet.

The cabinet shall be provided with a 1 1/4 inch [32 mm] double hub plate on top, and a 3/4 inch [19 mm] single hub plate on the bottom. All removable hubs shall have a gasket. A solderless connector, for size 6 AWG shall be provided on the bottom of the cabinet for grounding purposes.

The cabinet shall have two 3/4 inch [19 mm] stainless steel brackets for strap-type mounting on a wood or metal pole.

The cabinet shall provide for mounting of a maximum size, two circuit, NEMA flasher (specified above). The flasher must be easy to remove and replace.

The flasher mating connector shall be as specified under Part 8 of NEMA Standard Publication TS 1-1976.

The cabinet shall also provide for mounting of a solid state time switch. The cabinet shall accept a time switch with an inverted “T” screw hole mount. The bottom two holes shall be 3 inches [76 mm] apart from center to center.

The top hole shall be 6.625 inches [168 mm] from its center, perpendicular to the line connecting the bottom holes at their center. The top hole shall be 3 inches [76 mm] from the top of the cabinet. The maximum overall dimensions of the timer's housing shall be 10.25 inches [260 mm] high by 6.25 inches [159 mm] wide (with the door open 90 degrees) by 7.5 inches [191 mm] deep (with the door open 90 degrees).

The cabinet shall be provided with openings to allow adequate convection cooling of the electronic components.

These vents shall be so located and designed to prevent the entry of water and minimize the infiltration of dust and insects.

The cabinet shall be able to be used either as a flasher only or as a flasher with time switch. The cabinet shall be equipped with a ten section barrier terminal block with double 8 - 32 x 5/16 inch [8 mm] binder screw terminals or larger.

The terminals shall be wired and labeled as follows:

Terminals 1– 4 Shall be neutral with wireless connectors between them. Terminal 1 shall be for line

neutral, and shall have a solderless connector for a #6 AWG wire.

Terminal 5 – Line In

Terminal 6 – Flasher Hot

Terminals 7 – 8 Flash Circuit 1

Terminals 9 – 10 Flash Circuit 2

The 6-pin mating connector for the flasher shall be wired as described under Part 8 of the NEMA Standard Publication TS 1-1976.

All components, including the time switch, shall be mounted on the back panel. They shall be properly wired, and wiring shall be neat and firm. Conductors used in cabinet wiring shall be sized to meet code requirements for the current rating of the fuse or circuit breaker protecting that circuit.

The two load terminals of the flasher shall have fused receptacles and 8 amp cartridge fuses.

A magnetic circuit breaker shall be installed on the "line" or service side of the cabinet. The single pole breaker shall be 120 volt AC, 20 amp rated breaker.

The load side of the 20 amp breaker shall be protected by EDCO Model SPA-300, Davis Engineering Model DE-300, or equivalent, lightning arrester.

The City shall be provided a cabinet wiring diagram for each cabinet.

CONSTRUCTION METHODS

Flasher cabinets shall be installed on the poles as shown on the project plans and as directed by the Engineer.

MEASUREMENT AND PAYMENT

Flashers and cabinets shall be measured for payment by the number of units each, in accordance with the plans and specifications. The accepted number of flashers and cabinets shall be paid for at the contract unit price per the bid list, which shall be full compensation for the flasher, cabinet, installation, and incidentals.

Lump Sum Bid - Work performed and materials supplied under this item shall be considered subsidiary to the general bid item "Traffic Signal," Item 650.

BID ITEM:

Item 617.1: Flasher & Cabinet

ITEM 619
TYPE 332 CONTROLLER FOUNDATION

The purpose of this specification is to describe a controller foundation for the Type 170 controller in a Type 332 cabinet.

The work shall include furnishing and installing anchor bolts, concrete, reinforcing materials, excavation, ground rod, pull box, conduit, and other incidentals required for a complete foundation as shown on the detail.

MATERIALS:

Concrete shall be 3000 psi [21 MPa] strength at 28 days.

Anchor bolts shall be completely galvanized and of the dimensions shown on the Standard Detail.

One # 7 pull box, unless otherwise shown on the plans.

CONSTRUCTION METHODS:

Placement of anchor bolts shall be as shown on the plans. Failure to properly locate the bolts may be cause for the Contractor to demolish the improper foundation and reconstruct to the proper dimensions.

Concrete slab and concrete block on which the cabinet will sit shall be poured as one monolithic unit.

Concrete shall have a smooth finish free of brush marks or other mars.

Cabinets may be set on foundations after they have set a minimum of 72 hours. Cabinets scratched, dented or otherwise damaged prior to final acceptance shall be repaired to the City's satisfaction at no cost to the City.

Standard foundations shall contain two 3 inches [76 mm) conduits to the pull box in the slab, a 1 inch [25 mm) conduit drain that is cut flush with the concrete surface inside the cabinet, and fitted with a screen on the outside end, and two 1 inch [25 mm] conduits stubbed out and capped from the base of the slab approximately 12 inches [305 mm]. The slab shall be scored with a "Y" where the stubbed out conduits pass under.

The slab around the block shall sit above the surrounding grade two to four inches [50 mm to 102 mm], and shall be sloped slightly for drainage.

A 5/8 inch x 8-foot [16 mm x 2.4 m] copperweld ground rod shall be installed in the pull box as shown in the detail.

MEASUREMENT AND PAYMENT:

Unit Price Bid - Type 170 controller foundations shall be measured for payment by the number of units each, in accordance with the plans and specifications. The accepted number of controller foundations will be paid for at the contract unit price which shall be full compensation for the controller foundation, installation, and incidentals.

Lump Sum Bid - Work performed and materials supplied under this item shall be considered subsidiary to the general bid item "Traffic Signal," Item No. 650.

BID ITEMS:

Item 619.1: Type 332 Controller Foundation

Item 619.2: Type 332 Foundation, Transfer Existing Cabinet to Foundation, and Terminate Wires in Cabinet

ITEM 620
CONTROLLER PEDESTAL POST

The purpose of this specification is to describe a pedestal post with foundation for a Type 170 controller mounted in a Type 303, 336, or 337 cabinet.

The work shall include furnishing and installing the concrete foundation, reinforcing materials, excavation, post with fittings, rigid metal conduit to the nearest pull box, the ground rod in the nearest pull box, and incidentals required for a complete installation as shown on the Standard Detail.

MATERIALS:

Concrete shall be 3000 psi [21 MPa] strength at 28 days. The post shall consist of fully galvanized 4 inch [102 mm Schedule 40 pipe threaded on one end only to fit the coupling shown in the Standard Detail.

All other materials shall be as shown on the Standard Detail.

CONSTRUCTION METHODS:

Foundation shall be located as shown on the plans or as directed by the Traffic Design Engineer or Inspector.

Foundation tops shall have a smooth finish. Foundations placed in sidewalks shall be finished to a level 0.25 inch [6 mm] above the sidewalk, and with a 0.25 inch [6 mm] chamfer. Foundations finished too low or too high either will not drain or will create a tripping hazard, and will be cause for the Contractor to completely replace the foundation at no expense to the City.

Cabinets may be set on the posts after the foundation concrete has cured a minimum of 72 hours. Cabinets scratched, dented, or otherwise damaged prior to the final acceptance by the City shall be repaired to the City's satisfaction at no expense to the City.

A 5/8 inch x 8-foot [16 mm x 2.4 m] copperweld ground rod shall be installed in the adjacent pullbox as shown in the detail.

MEASUREMENT AND PAYMENT:

Unit Price Bid - Controller pedestal posts shall be measured for payment by the number of units each, in accordance with the plans and specifications. The accepted number of controller pedestal posts will be paid for at the contract unit price which shall be full compensation for the pedestal post, pipe, rod, incidentals, and labor.

BID ITEM:

Item No. 620.1: Controller Pedestal Post

ITEM 622
WOOD POLES

The purpose of this specification is to describe wood poles to be used in a traffic signal, street lighting, interconnect, or service pole system.

The work shall consist of furnishing and installing wood poles, anchors, excavation, backfill, guys, guy guards, ground rods, ground wires, fittings, incidentals, and labor as described herein and in the plans.

MATERIALS:

The lengths of wood poles shall be 25 feet [7.6 m] for service poles and 35 feet [10.6 m] for all other poles. Class 3 or better shall be used for traffic signal support poles. Class 4 or 5 may be used for service poles.

All poles covered by this specification shall comply with the national standards listed below, except where they conflict with the requirements of this specification. The order of precedence shall be this specification, then the following standards:

AAR Section 1-80: General Rules Governing the Loading of Commodities on Open Top Box Cars

AAR Section 5-80: Rules Governing the Loading of Forest Products Including Miscellaneous Building Materials on Open Top Cars

ANSI 05.1-79: Specifications and Dimensions for Wood Poles

AWPA P1-78 (Revised): Standard for Coal Tar Creosote for Land and Fresh Water Use

AWPA C1-84: All Timber Products - Preservative Treatment by Pressure Processes

AWPA C4-84: Poles - Preservative Treatment by Pressure Processes

AWPA A1-80: Standard Methods of Analysis of Creosote and Oil-Type Preservatives

AWPA A6-83: Method for the Determination of Oil-Type Preservatives and Water in Wood

AWPA M1-84: Standard for the Purchase of Treated Wood Products

AWPA M2-83: Standard for Inspection of Treated Timber Products

AWPA M4-84: Standard for the Care of Preservative-Treated Wood Products

AWPA M6-84: Brands Used on Forest Products

All poles shall be Southern Pine.

All poles shall be steam conditioned or kiln dried. The poles may be partially conditioned by natural air-seasoning and further conditioned by kiln drying or by the steam-vacuum process within the limits listed below.

The steam temperature employed shall not exceed 245° F (118 °C). The time duration for poles with specified circumferences 37.5 inches [953 mm] or less at 6 feet [1.8 m] from the butt shall not exceed 17 hours and for poles with specified circumferences larger than 37.5 inches [953 mm] at 6 feet [1.8 m] from the butt shall not exceed 20 hours.

Where kiln drying is employed, the maximum dry bulb temperature shall be increased gradually and shall not exceed 230 °F [110 °C].

For dry bulb temperatures over 200 °F [93 °C], the wet bulb depression shall not be less than 50 °F [10 °C] with the exception that during the first 24 hours there is no limitation on wet bulb depression. In compartment kilns operating at temperatures up to 170 °F [77 °C], the maximum wet bulb depressions shall not exceed 50 °F [10 °C] with the exception that during the first 24 hours there is no limitation on wet bulb depressions. In progressive-type kilns operating at temperatures up to 170 °F [77 °C], the maximum wet bulb depression shall not exceed 50 °F [10 °C], the maximum wet bulb depression shall not exceed 50 °F [10 °C] in the body of the kiln and 90 °F [32 °C] at the entrance to the kiln.

The average rate of growth measured on the butt in the outer 2 inches [50 mm] of poles having a circumference of 37.5 inches [953 mm] or less at 6 feet [1.8 m] from the butt, and in the outer 3 inches [76 mm] of poles having a circumference of more than 37.5 inches [953 mm] at 6 feet [1.8 m] from the butt, shall not be less than 6 rings per inch [25 mm]. Poles with 4 or 5 rings per inch [25 mm] are acceptable if 50% or more summerwood is present.

As an alternative, the ring count and summerwood measurements mentioned above may be made on an increment core taken at 6 feet [1.8 m] from the butt directly above the place where the average rate of growth is indicated on the butt surface.

The prohibited defects, permitted defects, and limited defects shall be as stated in ANSI 05.1, Sections 4.2, 4.3, and 4.4.

The dimensions and tolerances shall be as stated below and in accordance with the detail.

Poles shall not be more than 3 inches [76 mm] shorter or 6 inches [152 mm] longer than the nominal length. The length shall be measured between the extreme ends of the pole.

The minimum circumferences at 6 feet [1.8 m] from the butt and at the top, for each length and class of pole, shall be as described in ANSI 05.1. The circumference at 6 feet [1.8 m] from the butt of a pole shall not be more than 7 inches [178 mm] or 20% larger than the specified minimum, whichever is greater. The top dimensional requirement shall apply at a point corresponding to the minimum length permitted for the pole.

The true circumference class shall be determined in accordance with ANSI 05.1. All poles shall be supplied as ANSI classes.

A tolerance of not more than 2%, in circumference, is allowed for shrinkage after treatment.

Outer bark shall be completely removed from all poles. No patch of inner bark more than 1 inch [25 mm] wide and 6 inches [152 mm] long shall be left on the pole surface between the top and 2 feet [610 mm] below the ground line.

All poles shall be neatly sawed at the top and at the butt along a plane which shall not be out of square with the axis of the pole by more than 2 inches [50 mm] per foot of diameter of the sawed surface. Beveling at the edge of the sawed butt surface not more than 1/12 inch [2 mm] the butt diameter in width, or an equivalent area unsymmetrically located, is permitted.

Completely overgrown knots, rising more than 1 inch [25 mm] above the pole surface, branch tubs, and partially overgrown knots shall be trimmed close. Completely overgrown knots less than 1 inch high need not be trimmed. Trimming may be done by shaving machine or by hand.

If shaving is used, the depth of the cut shall not be more than necessary to remove inner bark and to trim smoothly and closely all branch stubs and overgrown knots. There shall be no abrupt change in contour of the pole surface between the groundline and the aboveground sections. The lower 2 feet [610 mm] of poles may be trimmed to remove wood fibers causing butt flare, provided sufficient sapwood remains to obtain the minimum penetration requirement.

All poles shall be bored, gained, roofed, and cut to length prior to final treatment, and in accordance with the Standard Details.

The following information shall be burn-branded legibly and permanently on the face of each pole:

1) The initials "CSAPW"

2) Supplier's code or trademark

3) Plant location & year of treatment

4) Code letters denoting pole species and preservative used

5) The true circumference-class numeral and numerals indicating pole length

6) An "R" on retreated poles

The code letters, not less than 5/8 inch [16 mm] in height, designating the pole species and preservative used shall be in accordance with AWPA M6.

The bottom of the brand shall be placed squarely on the face of the pole and at 10 feet ± 2 inches [3.05 m ± 50 mm] from the butt. The "CSAPW" initials shall be placed 5 inches [127 mm] above this information. The butt of all poles shall be marked with the proper class and length.

The arrangement and order of the code letters and figures shall be as follows:

CSAPW City of San Antonio, Public Works initials

PTC Supplier's code or trademark (Example: Pole Treating Company)

F-80 Plant location & treatment year (Example: Forestville-1980)

SPC Species & preservative codes (Example: Southern Pine, creosote). An "R" placed on the right side of the "C" denotes retreated (Example: SPC-R).

4-45 Size (Example: Class 4, 45 foot [13.7 m] length)

The preservative used shall be creosote. The creosote shall be a distillate derived from tar produced by the high temperature carbonization of bituminous coal and conform to the requirements of AWPA P1 when analyzed in accordance with the methods in AWPA A1, Sections 2, 3, 4, either 5 or 9, and 6.

All poles shall be impregnated with creosote by the empty-cell pressure process, full length treatment, in accordance with AWPA C1 and C4. The initial air pressure or vacuum shall be maintained while the cylinder is being filled with preservative. At the conclusion of the pressure period and after the cylinder has been emptied of preservative, a vacuum of no less than 22 inches [559 mm] at sea level may be created. The temperature of the preservative during the entire pressure period shall not exceed 210 °F [99 °C].

The penetration of the creosote shall not be less than 3 inches [76 mm] or 90% of the sapwood. The determination of penetration shall be by bore core sampling. Penetration boring shall be conducted in accordance with AWPA C4 and AWPA M2, Section 5. The measurement of penetration in the core shall be conducted in accordance with AWPA M2, Section 5.3.

The minimum retention of the creosote shall be 7.5 pounds per cubic foot [0.096 kilograms per cubic meter] by chemical assay. Retention sampling and testing shall be conducted in accordance with AWPA M2, Section 5.421 and AWPA A6.

All increment holes shall be promptly plugged with creosote treated, tight-fitting wooden plugs. Care will be used in selecting the proper diameter plugs, and in driving, to avoid breaking or splitting the plug.

Pretreated poles may not be used.

The inspection of poles before treatment, during treatment, and after treatment shall be conducted in accordance with AWPA M2.

Each inspection shall be covered by an Inspector's Report which shall include all applicable information defined in AWPA M2, Section 7. Inspection reports shall be supplied to the Traffic Design Engineer upon request.

CONSTRUCTION METHODS:

Wood poles shall be placed in the ground to the depth shown on the applicable detail. After each pole is set in the ground, the pole hole shall be backfilled with select backfill. Backfill shall be free of rocks and debris, and placed in layers of no more than six inches before layer compaction. Each layer shall be moistened and thoroughly compacted.

Guy Anchors shall have concrete foundations.

MEASUREMENT AND PAYMENT:

Wood poles shall be measured for payment by the number of units each in accordance with the project plans and specifications. The accepted number of wood poles shall be paid for at the contract unit price which shall be full compensation for the wood poles, anchors, down guys, incidentals and labor. Overhead guys to adjacent poles are not paid for directly, and therefore not contained in the following listing.

BID ITEM:

Item 622.1: Wood Pole (No down guys)

Item 622.2: Wood Pole (w/ 1 down guy)

Item 622.3: Wood Pole (w/ 2 down guys)

Item 622.4: Wood Pole (w/ 1 sidewalk guy)

Item 622.5: Wood Pole (w/ 2 sidewalk guys)

Item 622.6: Wood Pole (w/ 1 down & 1 sidewalk guy)

Item 622.7: Existing Pole (w/1 new down guy)

Item 622.8: Existing Pole (w/2 new down guys)

Item 622.9: Existing Pole (w/1 new sidewalk guy)

Item 622.10: Existing Pole (w/2 new sidewalk guys)

Item 622.11: Existing Pole (w/ 1 new down guy & 1 new sidewalk guy)

ITEM 624
STEEL POLES

The purpose of this specification is to describe steel strain poles, steel mast arm poles, Type I poles, pedestrian pushbutton posts, and steel dual signal arm mast arm poles for use in traffic signal construction. The work shall consist of furnishing and installing steel poles as shown in the project plans, and in the standard details below defined.

REFERENCES:

The standard details consist of the TxDOT Standard Assembly Drawings for Traffic Signal Support Structures, Drawings SMA-80, DMA-80, MA-C, LUM-A, MA-D, SP-80, and TS-FD, with current revisions. Pole lengths and configuration shall be as specified in the plans or Invitation for Bid.

MATERIALS:

The steel pole designs shall conform to the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals with Interim Specifications thereto.

This specification and the referenced standard details shall constitute the only acceptable design for the assemblies.

Mast arms, if required, shall be fabricated straight in the unloaded condition unless otherwise stated.

Fabrication and welding shall be in accordance with the Item 441 “Steel Structures” of the TxDOT Standard Specifications. All welded joints shall develop the full required strength of the member.

Shop drawings may not be required since the poles shall be fabricated to the referenced standard details. Any special pole design or deviation from the standard details will require submission of 3 copies of shop drawings of the complete assembly including anchor bolts. Any deviation from the standard details for standard pole configurations shall be declared at the time of bid submittal and may be cause for rejection.

The assembly shall be fabricated to a design wind speed of 80 miles/hour [129 kph], and this wind speed shall be stamped and identified permanently on a surface visible after erection of the pole and arm, preferably on the base plate or on the pole tag.

The shaft for the pole or arm shall be round or octagonal in section and shall be tapered. Bolted slip-joints are permissible in mast arms 40 feet [12 m] and longer. Circumferential welds, other than at the ends of shafts, are not permitted. The exterior of longitudinal seam welds shall be ground or otherwise smoothed to the same appearance as other shaft surfaces.

Longitudinal seam welds for pole or mast arm sections shall have 60% minimum penetration except longitudinal seam welds shall be complete penetration welds within six inches [152 mm] on the circumferential base welds. A maximum of two longitudinal seam welds may be made in pole sections and only one longitudinal seam weld is permitted in mast arms. Low hydrogen electrodes, or the equivalent in wire and flux for automatic welding, will be required for all welds. Preheat will be required for welding pole or mast arm shafts to their respective bases in accordance with Item 441, "Steel Structures" of the TxDOT Standard Specification.

Poles shall be supplied smooth without grommets or other factory-installed signal head mounting provisions. The ends of mast arms shall be capped with a slip-on cap similar to the pole. Poles shall be supplied without tenons or other pole-end mounting provisions.

Material for pole and mast arm shafts shall conform to the requirements in the standard details and shall comply with the requirements of ASTM A570 Grade 50, A572 Grade 50, A670 Grade 50, or A595 Grade A. Material supplied under the A570 Grade 50 or A595 Grade A specifications shall meet their associated chemical and bend test requirements with the further stipulation that the materials must meet a minimum yield of 50 ksi and a minimum elongation of 18% in 8 inches [203 mm] or 23% in 2 inches [50 mm] prior to brake or tube forming operations. A570 Grade 50 material in thickness up to 5/16 inch [8 mm] is also acceptable providing it meets the above stated chemical, and bend test, yield, and elongation requirements. A595 Grade A material which can be shown by tests to have a minimum of 50 ksi yield adjacent to base welds after fabrication shall also be acceptable.

Mill test reports and/or laboratory test certifications shall be provided to show that the materials conform to these requirements.

The terminal block described in the standard details shall be provided and installed by the supplier and the cover plate with gasket and insulation shall be in place for shipment.

A metal cap at the top of all pole shafts shall be secured using galvanized or stainless steel set screws.

The 8 foot [2.4 m] or 10 foot [3 m] luminaire arm, if specified, shall be of the type shown on the standard detail. The connections to the pole shall be with simplex fittings, the castings of which shall be true to pattern in form and dimensions with no sharp unfilleted angles or corners. The fittings shall have no defects affecting their strength for the service intended.

The mast arm assembly and pole assembly shall be hot-dip galvanized unless so otherwise stated in the Special Provisions, project plans, or Invitation for Bid.

Assemblies shall be so designed as to provide proper filling, venting, and draining during the cleaning and galvanizing operation. All parts, nut anchorages, and the template, shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All screws, nuts, bolts, washers, shims, and anchor bolts shall be galvanized in conformance with the specification ASTM A153, Class C or D, unless otherwise specified. All threaded material shall be tapped after galvanizing. Any part of the mast arm assembly, from which the galvanizing has been knocked or chipped to bare metal in fabrication or transit, shall be repaired by application of galvanizing-repair compounds in accordance with the manufacturer's recommendations. The galvanizing repair shall be applied so as to provide a final assembly which is neat in appearance.

All sheared or cut edges and all other exposed edges shall be rounded or chamfered to an approximate 1/16th inch [1.5 mm].

Each mast arm or strain pole assembly shall be shipped as a complete unit with fittings either installed or packaged in such a manner that all parts remain with their associated major components during shipment.

The use of the standard details does not relieve the supplier of the responsibility for providing proper fit of mast arm assembly components.

The supplier shall furnish, at the time of delivery, 3 copies of mill certificates reflecting the physical and chemical properties of the base metal of the pole and mast arm shafts, base plates, luminaire arm when called for, and anchor bolts. In addition to the specified Mill Test Reports, copies of the galvanizing test report shall be furnished to the City.

All items shall be identified with a weatherproof tag. This tag shall minimally identify the manufacturer, date of fabrication, and maximum arm length the shaft can accommodate.

CONSTRUCTION METHODS

Poles shall be installed on the foundations as required by the applicable standard detail.

All mast arms shall be field drilled for wire holes to conform to the mounting bracket. On the Astro-Brac type mountings, wire shall be contained within the bracket plate and arms. On other types of mounts, wire shall be placed inside the mounts where possible. On mountings that do not so allow, the wire shall not be visible to oncoming traffic, and concealed behind the signal head.

Any poles or arms that have been scratched or damaged shall be replaced or repaired according to the directions of the Traffic Design Engineer. No repairs shall be made prior to seeking this direction from the City. Poles and arms found to have cold galvanizing applied without the expressed prior approval of the Traffic Design Engineer shall be subject to replacement by the Contractor at no expense to the City.

Poles shall not be set on any foundation until it has achieved 3000 psi [21 MPa].

The Contractor shall pay attention to the locations shown on the plans for quadrant locations of mountings and ped buttons. Ped buttons shall be mounted per the specifications. Holes in steel poles resulting from misdrilled poles shall result in the pole or pole shaft being rejected and the item replaced correctly at no expense to the City.

All Steel poles shall have the gap between the fountation and the base plate grouted.

MEASUREMENT AND PAYMENT:

Steel poles shall be measured as units each, including the mast arm(s) where applicable. Poles shall be paid for at the contract unit price which shall be full compensation for poles, arms, fittings, and incidentals.

BID ITEMS:

Item 624.1: Strain Pole 26 feet [8 m]

Item 624.2: Strain Pole 30 feet [9 m]

Item 624.3: Strain Pole 34 feet [10 m]

Item 624.4: Mast Arm Pole 15 feet [4.5 m]

Item 624.5: Mast Arm Pole 20 feet [6 m]

Item 624.6: Mast Arm Pole 24 feet [7 m]

Item 624.7: Mast Arm Pole 28 feet [8.5 m]

Item 624.8: Mast Arm Pole 32 feet [9.7 m]

Item 624.9: Mast Arm Pole 36 feet [11 m]

Item 624.10: Mast Arm Pole 40 feet [12 m]

Item 624.11: Mast Arm Pole 44 feet [13 m]

Item 624.12: Dual Mast Arm Pole 20 feet & 28 feet [6 m & 8.5 m]

Item 624.13: Dual Mast Arm Pole 20 feet & 36 feet [6 m & 11 m]

Item 624.14: Dual Mast Arm Pole 24 feet & 24 feet [7 m & 7 m]

Item 624.15: Dual Mast Arm Pole

Item 624.16: Dual Mast Arm Pole

Item 624.17: Dual Mast Arm Pole

Item 624.18: Dual Mast Arm Pole

Item 624.19: Dual Mast Arm Pole

Item 624.20: Mast Arm Pole; 15 feet [4.5 m] Sig; w/ 8 feet [2.4 m] Lum

Item 624.21: Mast Arm Pole; 20 feet [6 m] Sig; w/8 feet [2.4 m] Lum

Item 624.22: Mast Arm Pole; 24 feet [7 m] Sig; w/8 feet [2.4 m] Lum

Item 624.23: Mast Arm Pole; 28 feet [8.5 m] Sig; w/8 feet [2.4 m] Lum

Item 624.24: Mast Arm Pole; 32 feet [9.7 m] Sig; w/8 feet [2.4 m] Lum

Item 624.25: Mast Arm Pole; 36 feet [11 m] Sig; w/8 feet [2.4 m] Lum

Item 624.26: Mast Arm Pole; 40 feet [12 m] Sig; w/8 feet [2.4 m] Lum

Item 624.27: Mast Arm Pole; 44 feet [13 m] Sig; w/8 feet [2.4 m] Lum

Item 624.28 to 624.34 for other combinations as needed.

Item 624.35: Type I Signal Pole; 10 feet [3 m]

Item 624.36: Type I Signal Pole; 7 feet [2 m]

Item 624.37: Pedestrian Pushbutton Post

ITEM 625
TRAFFIC SIGNAL BASE

The purpose of this specification is to describe minimal requirements for a traffic signal pedestal base for use in traffic signal or warning beacon systems.

The work shall include furnishing and installing traffic signal base, including anchor bolts, nuts, washers, and aluminum stand pipe as shown on the plans, in accordance with these specifications and the project plans.

MATERIALS:

The traffic signal pedestal base shall be made of square cast aluminum with natural finish, minimum weight of 21 lbs.[9.53 kg] with dimensions as follows:

Height: 15 inches [381 mm]
Width: 13 3/4 inches [349 mm]
Depth: 3 3/4 inches [95 mm]

Upper end shall be threaded to receive a 4 inch [102 mm] aluminum pipe shaft.

The base shall be of such design that it may be fastened to a foundation with four (4) 3/4 inch [19 mm] anchor bolts located 90 degrees apart on the bottom of the base. There shall be slots in the bottom of the base 1 1/2 inch [38 mm] wide and 2 1/2 inch [64 mm] long measured along the circumference of the bolt circle, allowing a proper fit even if the bolts are placed slightly off center.

The base shall accommodate bolt circles of a minimum of 12 inches [305 mm] through a maximum of 14 1/2 inches [368 mm] and anchor bolts with a minimum of 5/8 inch [16 mm] through 1 inch [25 mm] diameter.

The base shall be equipped with a removable plastic door. Door opening shall be free of burrs and sharp edges and be no less than 8 1/2 inches [216 mm] square. The door shall be attached to the base using one socket button head screw to prevent unauthorized entry.

The base shall be fabricated free of voids, pits, dents, molding sand and excessive foundry grinding marks. All design radii shall be smooth and intact. Exterior surface finish shall be smooth and cosmetically acceptable by being free of molding fine, cracks and other exterior blemishes.

The base shall be fabricated from new aluminum ingot. No scrap materials shall be used. Minimum requirements as follows:

Aluminum Alloy	319	Elogation(% in 2 inches [50 mm])	1.5
Tensile Strength, KSI	28	Brinell Hardness	70-100
Yield Strength, KSI	14		

STRUCTURAL REQUIREMENTS

FRANGIBILITY: The base shall meet or exceed 1985 AASHTO breakaway requirements. Test reports from an FHWA approved independent laboratory shall be provided certifying that the base has been tested and meets all applicable requirements. In addition, a statement of certification from the FHWA stating such tests have been accepted and approved shall be supplied.

STRUCTURAL INTEGRITY: In order to prove structural soundness, a certification from a recognized independent structural laboratory shall be provided certifying that the base will withstand a bending moment of 10,750 ft. lbs [14 575 N•m]. Such test shall be performed in the following manner:

A force shall be applied at a distance of 10 feet [3 mm] from the bottom of the base in order to produce a moment. All bases must reach a moment capacity of 10,750 ft. lbs. [14 575 N•m] without breaking cracking or rupturing in any manner.

After force (P) has been removed, the lever arm (A) shall return to within .250 inch [6 mm] of its original rest position.

All test shall be made using 4 inches [102 mm] Schedule 40 Steel Pipe.

DOOR REQUIREMENTS
Door shall be injection molded from ABS plastic or approved equal to deter vandalism and theft and having the properties as indicated on Table 1:

The door shall exhibit the following properties:

Have an edge thickness of .25 inch [6 mm] and a minimum thickness of .156 inch [4 mm]:

Contain flame retardant, meeting or exceeding Underwriters Laboratories UL 94 Test H.S.

Color shall be gray aluminum tone unless otherwise specified.

Contain ultra violet inhibitors and stabilizers for protection against U.V. degradation.

Shall be injection molded with a smooth front finish.

All surfaces shall be flat and straight without blisters, buckling or warping.

BID ITEMS:

Item 625.1: Traffic Base; 7 feet [2.1 m) pole

Item 625.2: Traffic Base; 10 feet [3.1 m] pole

Item 625.3: Traffic Base; 15 feet [4.6 m] pole

Shall have reinforcing ribs. The bottom of the door shall have 2 injection molded lugs with slots of the proper width and depth to fit the base door opening.

HARDWARE
The base shall be supplied with a set of 4 Anchor Bolts 3/4 inch [19 mm] Dia. by 18 inches [457 mm] length material per ASTM-A-572 galvanized per ASTM-A-153. Each Bolt shall have (1) Hex Nut and (1) Flatwasher.

CONSTRUCTION METHODS

The traffic signal bases shall be installed on the foundations as required by the applicable standard detail.

All pole shafts shall be field drilled for wire holes to conform to the mounting bracket. On mounting brackets, wire shall be placed inside the mounts where possible. On mountings that do not so allow, the wire shall not be visible to oncoming traffic.

Any poles or bases that have been damaged shall be replaced at no cost to the City or repaired according to the directions of the Traffic Design Engineer. No repairs shall be made prior to seeking this direction from the City.

The Base shall not be set on any foundation until it has set for at least 72 hours. Poles and hardware may be set on the foundations after the compressive strength of the concrete has reached at least 2500 psi [17 MPa].

The Contractor shall pay attention to the locations shown on the plans for quadrant locations of mountings and pedestrain buttons. Pedestrain buttons shall be mounted per the specifications. Holes in poles resulting from misdrilled poles shall result in the pole or pole shaft being rejected and the item replaced correctly at no expense to the City.

MEASUREMENT AND PAYMENT

Traffic signal bases and poles shall be measured as units each in accordance with the the project plans and specifications.

The number of bases and poles shall be paid for at the contract unit price which shall be full compensation for aluminum base, aluminum pole, anchor bolts, nuts washers fittings, incidentals and labor.

TABLE 1

	ASTM Method	VALUE
Tensile @ yield (1/8 inch) [3 mm]	D638	6600 PSI [46 MPa]
Flexural @ yield	D790	11,000 PSI [76 MPa]
Rockwell Hardness	D785	101 (R Scale)
Notched Izod	D256	5 ft. lb./in.[876 N•m]

ITEM 626
POLE FOUNDATIONS

The purpose of this specification is to describe foundations for steel strain poles, Type I poles, and steel mast arm poles.

The work shall consist of furnishing and installing pole foundations, excavation, conduit, concrete, anchor bolts, reinforcing steel, barricading, ground rod, and templates in accordance with the project plans and specifications.

MATERIALS:

Anchor bolts shall conform to the requirements in the Texas Department of Transportation Standard Detail TS-FD, Traffic Signal Pole Foundations. Dimensions shall be based on the foundation size required for the arm lengths, number of arms, and design wind speed.

The anchor bolts shall have the standard nut anchorage. Nuts shall comply with the requirements of ASTM A563 Grade A or better, heavy hex. Washers shall comply with the requirements of the Item 447, "Structural Bolting" of the TxDOT Standard Specifications.

One circular steel template shall be provided for each mast arm and strain pole foundation assembly but it may be shipped without the anchor bolts attached. The lower nut shall be tack welded to the template.

The entire anchor bolt as well as exposed nuts and washers shall be hot-dipped galvanized.

Threads for anchor bolts shall be rolled or cut threads of unified coarse thread series except for ASTM A193-B7 bolts which shall be 8 pitch thread series. If rolled, the diameter of the unthreaded portion shall not be less than the minimum pitch diameter nor more than the maximum major diameter of the threads. Threads shall have Class 2 fit tolerances. Galvanized nuts shall be tapped after galvanizing.

CONSTRUCTION METHODS:

Foundations shall be constructed in the manner shown on the Standard Detail. The Contractor may have a Texas Cone Pentrometer test performed at his expense to determine the required foundation depth, or use the maximum depth for the type of foundation required without this test. If a pentrometer test is done, 3 copies of the test results shall be certified and submitted to the Inspector and Traffic Design Engineer.

MEASUREMENT AND PAYMENT:

Pole foundations shall be measured for payment by the number of units each, in accordance with the project plans and specifications.

The accepted number of pole foundations shall be paid for at the contract unit price for the type of foundation specified which price shall be full compensation for the foundation and all incidentals.

BID ITEMS:

Item 626.1: Pole Foundation Type 30-A

Item 626.2: Pole Foundation Type 30-B

Item 626.3: Pole Foundation Type 36-A

Item 626.4: Pole Foundation Type I Pole

Item 626.5: Pole Foundation Ped Button Post

ITEM 628
TRAFFIC SIGNAL CONDUIT SYSTEM

The purpose of this specification is to describe conduit for use in a traffic signal system. The work shall consist of furnishing and installing electrical conduit, fittings, excavating, boring, pavement patching, barricading, drilling, backfilling and compaction in accordance with the Inspector's directions, project plans and specifications.

MATERIALS:

All conduits and fittings shall be listed by Underwriters Laboratories (UL) and conform to National Electrical Code (NEC) standards. Unless otherwise specified, all conduit to be installed underground shall be rigid polyvinyl chloride (PVC) non-metallic type conforming to the requirements of UL651 for rigid non-metallic conduit. PVC conduit and fittings shall be Schedule 40, heavy wall, gray electrical conduit, manufactured from high-impact material and shall be rated for use at 90 °C.

PVC duct designed for direct burial installation without concrete encasement shall comply with one of the following standards:

a) Conduit marked EPC-40-PVC

b) Conduit marked Schedule 40 PVC TC-2

c) Conduit marked DB-120 S ASTM F-512

d) Conduit marked DB-120 TC-8

All conduit and fittings to be installed above ground shall be galvanized rigid metal type manufactured conforming to the requirements of UL6 for rigid metallic conduit. Non-threaded couplings shall not be used. If specifically allowed by the Traffic Design Engineer, Schedule 80 PVC pipe meeting CPS requirements may be allowed for service conduits.

Flexible conduit, if called for on the project plans, shall be a liquid-tight flexible metal type. The conduit shall have a flexible galvanized steel core over which is extruded a PVC cover resistant to sunlight. Approved liquid-tight fittings shall be furnished and installed with the conduit.

Sampling and testing procedures shall conform to UL Standards. Samples for testing, if requested by the City, shall be furnished at the Contractor's expense. Samples of conduit shall be tested by UL Standards and be approved for use prior to installation on the project.

For City purchasing, samples for testing and evaluation may be required at time of Bid, as specified in the Invitation for Bid.

Conduit warning tape shall be a 4 mil inert plastic film specially formulated for prolonged use underground. All tape shall be highly resistant to alkalis, acids, and other destructive agents found in soils.

Tape shall have a continuous printed message warning of the location of underground conduits. The message shall be in permanent ink specifically formulated for prolonged underground use and shall bear the words CAUTION–ELECTRIC LINE BURIED BELOW, or other such approved phrase, in black letters on a yellow or red background.

Metal junction boxes and their covers which will be exposed to the weather shall be fabricated from steel, be rain-tight, and UL approved for exterior use. Size shall be adequate for the use as depicted on the plans.

CONSTRUCTION METHODS

Conduit runs as shown on the plans may be changed with the Inspector's approval to avoid obstructions.

Sidewalk slabs that require conduit to be placed under them shall be neatly sawcut at the nearest joint and the entire slab removed and replaced. Sawcutting across slabs is considered unsightly and will not be tolerated. Exceptions to this requirement may only be made by the Traffic Design Engineer on conduit runs in excess of 50 feet [15 m] that are called to be bored.

The Contractor may, at his option and expense, use a larger size conduit than specified provided the larger size is continuous for the entire length of the run from outlet to outlet. Reducing couplings shall not be permitted. Changes in the location and size shown on the project plans shall be documented by the Contractor and submitted to the Traffic Design Engineer on the As-Built traffic signal plans.

The PVC conduit shall be cut square and trimmed to remove all rough edges. Conduit connections shall be of the solvent weld type. Where a connection is made to a steel conduit, the coupling shall be a PVC female adapter.

Expansion fittings shall not be used on buried PVC conduit runs between pull boxes unless specified. Expansion fittings shall be installed in conduit runs in which both ends of the conduit are fixed in place such as between two foundations. Expansion fittings shall be installed in conduit runs which cross an expansion joint in a concrete structure, and any rigid metal conduit run exposed to sunlight and in excess of 50 feet (15 m) in length. In such cases, expansion fittings shall be installed every 50 feet (15 m). Approved expansion fittings shall allow for a linear expansion of up to 6 inches (152 mm) and shall be installed with the fitting in the halfway position.

In cases where a trench has to be left open overnight, a minimum of 6 inches (152 mm) of backfill material shall be used as a protective cover to eliminate contraction of the conduit system. The backfill material shall be removed by the Contractor upon the Inspector's request to facilitate inspection.

Any obstructions to the trenching operation such as existing improvements, utilities, roof drains, irrigation lines, structures, buildings, foundations, and survey markers shall be protected from damage by the Contractor during construction and until completion of the work. In the event of damage by the Contractor to any facility or utility, the Contractor shall be responsible for repair/replacement at his expense with materials and methods which will leave the facility in as good as or better than the original condition.

Backfill containing large rocks, paving materials, asphalt chunks, cinders, large or angular substance, or corrosive materials shall not be placed in an excavation where materials may damage raceways, cables, or other substructures or prevent adequate compaction of fill or contribute to corrosion of raceways, cables or other substructures.

Where necessary to prevent physical damage to the raceway or cable, protection shall be provided in the form of granular or selected material, suitable running boards, suitable sleeves, or other means approved by the Inspector.

All PVC conduit shall be stored and handled in an approved manner to minimize ultraviolet deterioration due to exposure to sunlight.

Conduits on CPS poles shall be located as specified by CPS.

Conduits in protected areas such as behind curbs, in sidewalks, etc., that are not subject to vehicular traffic shall be at a minimum depth of 18 inches [457 mm]. Conduits installed under roadways, driveways, or any other areas where it is possible for vehicles to drive presently or with future development shall be at a minimum depth of 30 inches [762 mm]. When conduits cannot be placed at the minimum depths described above due to obstructions or conflicts with other utilities, conduits shall be encased in concrete.

Encased conduits shall have a minimum encasement of 3 inches [76 mm] around the entire conduit, not just on the top. Conduits shall be supported with masonry block or conduit bridges every 5 feet [1.5 m] so conduits may be completely encased.

Conduits installed under existing paved roadways, paved alleys, and paved driveways shall be installed by jacking, boring, or drilling. Open trench excavations across an existing paved street, drive, or alley will not be tolerated unless specific written approval had been previously granted by the Traffic Design Engineer. Jacking and drilling pits shall be kept clear of the existing edge of roadway by a minimum distance of 2 feet [610 mm].

Any conduits installed by special permission as described above in an open trench in a paved area shall be concrete encased from outlet to outlet. Trench repair shall be to City standards.

Conduit installed in railroad right-of-way shall be at the depth specified by the railroad.

Except for factory bends, conduit bends shall have a radius of not less than that specified in the NEC. Conduits shall be bent without crimping or flattening, using the longest radius practical.

Existing underground conduits to be incorporated into the final signal system shall be cleaned out with compressed air and a mandrel run through to remove any obstructions.

Conduits for future use shall have a #8 bare bond wire installed in the conduit with at least 2 feet [610 mm] of pull wire coiled back into the conduit, and the conduit capped with a standard plastic conduit cap.

A 3 inch [76 mm] “Y” shall be sawed into the top of the curb directly over the location where a new conduit passes under the curb to mark its location.

The Contractor shall place warning tape in all trenches in which new conduit is placed. All warning tape shall be placed at a depth of 6 to 8 inches [152 mm to 203 mm] below final grade.

Conduit entering pull boxes shall terminate a minimum of 3 inches [76 mm] inside the box wall. Conduit shall be 2 to 4 inches [50 mm to 102 mm] above the bottom of the box and not be placed such that it interferes with the lid when wire is installed.

Conduit ends shall be capped with a plastic end cap fitting until the wire pulling operation is begun. When end caps are removed, ends of all PVC conduits shall be fitted with end bells prior to wire installation. Approved insulated grounding bushings shall be used on the ends of all metallic conduit.

Conduits embedded in concrete structures shall be securely attached to the reinforcing steel at intervals of approximately 12 inches [305 mm] vertically and horizontally.

Where bonding is not continuous, expansion fittings shall be provided with a bonding jumper of flexible wire. Where it is not possible to use expansion fittings, sleeves of sufficient size shall be installed to provide a minimum of 1/2 inch [13 mm] clearance between the conduit and inside wall of the sleeve. The sleeve shall be discontinuous at the expansion joint.

All conduits shall be sealed with Duct-Seal after all wiring is completed.

MEASUREMENT AND PAYMENT

Traffic signal conduit shall be measured for payment by the linear foot [meter] for each size diameter and type as follows:

a) From center to center of pull box

b) From edge of foundation to center of pull box

c) From edge of foundation to edge of foundation

d) From end of conduit to center of pull box

e) From end to end of conduit if no pull box

f) From edge of wood pole to edge of foundation or center of pull box

g) From ground line up wood pole to junction box or weatherhead

Conduit shall be measured in accordance with the project plans and specifications. The accepted number of linear feet [meter] of conduit shall be paid for at the contract unit price which shall be full compensation for the conduit, fittings, installation, backfill, surface and subsurface repairs and incidentals.

BID ITEMS:

Item 628.1: Conduit Trenched 1 inch [25 mm] PVC

Item 628.2: Conduit Trenched 1 1/2 inches [38 mm] PVC

Item 628.3: Conduit Trenched 2 inches [50 mm] PVC

Item 628.4: Conduit Trenched 3 inches [76 mm] PVC

Item 628.5: Conduit Trenched 2 inches & 3 inches [50 mm & 76 mm] PVC

Item 628.6: Conduit Trenched (2)3 inches [76 mm] PVC

Item 628.7: Conduit Trenched 4 inches [102 mm] PVC

Item 628.8: Conduit Trenched 1 inch [25 mm] RMC

Item 628.9: Conduit Trenched 2 inches [50 mm] RMC

Item 628.10: Conduit Trenched 3 inches [76 mm] RMC

Item 628.11: Conduit Trenched/Encased 2 inches [50 mm] PVC

Item 628.12: Conduit Trenched/Encased 3 inches [76 mm] PVC

Item 628.13: Conduit Trenched and Encased 2 inches & 3 inch es [50 mm & 76 mm] PVC

Item 628.14: Conduit Trenched and Encased (2) 3 inches [76 mm] PVC

Item 628.15: Conduit Trenched and Encased 2 inches [50 mm] RMC

Item 628.16: Conduit Trenched and Encased 3 inches [76 mm] RMC

Item 628.17: Conduit Trenched and Encased 4 inches [102 mm] RMC

Item 628.18: Conduit Bored 1 inch [25 mm] PVC

Item 628.19: Conduit Bored 1 1/2 inches [38 mm] PVC

Item 628.20: Conduit Bored 2 inches [50 mm] PVC

Item 628.21: Conduit Bored 3 inches [76 mm] PVC

Item 628.22: Conduit Bored 2 inches & 3 inches [50 mm & 76 mm] PVC

Item 628.23: Conduit Bored (2) 3 inches [76 mm] PVC

Item 628.24: Conduit on Pole 1 inch [25 mm] RMC

Item 628.25: Conduit on Pole 1 1/4 inches [32 mm] RMC

Item 628.26: Conduit on Pole 1 1/2 inches [38 mm] RMC

Item 628.27: Conduit on Pole 2 inches [50 mm] RMC

Item 628.28: Conduit on Pole 3 inches [76 mm] RMC

Item 628.29: Conduit (Special Backfill) 1 inch [25 mm] PVC

Item 628.30: Conduit (Special Backfill) 1-1/2 inches [38 mm] PVC

Item 628.31: Conduit (Special Backfill) 2 inches [50 mm] PVC

Item 628.32: Conduit (Special Backfill) 3 inches [76 mm] PVC

ITEM 630
CABLE AND CONDUCTORS

The purpose of this specification is to describe cable and conductors for use in traffic signal installations. Tthe work shall consist of furnishing and installing electrical conductors and cables in accordance with the project plans and these specifications.

MATERIALS:

Electrical conductors shall be thermoplastic insulated electrical wire or cable as described on the plans. Conductors shall conform to the National Electrical Code (NEC) and Underwriters Laboratories (UL) standards and other applicable industry standards.

Cable and conductors shall be UL listed and rated for 600 volt operation except as otherwise specified for certain cables serving interconnect and detector loop uses. The UL label shall be present on each reel, coil, or spool of wire. If requested by the City, the Contractor shall submit the manufacturer's written certification that the product conforms to the requirements of these specifications.

All single conductors shall have plain, distinctive, permanent markings on the outer surface throughout the entire length showing the manufacturer's name or logo, voltage rating, and AWG size.

If a a copper bonding wire is needed, it shall be a #8 solid copper bare bond wire.

All wire shall be annealed copper and shall be uncoated unless otherwise specified. Wire shall be solid conductor for #8 AWG size and smaller, conforming to the requirements of ASTM B 3 for annealed bare copper wire. Conductors for sizes #6 AWG and larger shall be stranded and shall conform to ASTM B 8 for Class B stranding, unless otherwise specified. The conductors shall be insulated as described on the project plans and shall meet or exceed the requirements of UL 83. The insulation thickness shall conform to the requirements of the NEC.

SECTION I–SINGLE CONDUCTORS:

Wire insulation colors applicable to single conductors shall be as follows (not applicable to conductors contained within IMSA cables):

Color	Circuit Use
Red	Red Signal Dont Walk or Hand Photocell Control Line Red Flasher
Yellow	Yellow Signal Yellow Arrow Yellow Flasher
Green	Green Signal Green Arrow Walk or Man
White	Common Neutral
Black	Photocell Hot Line Street Lights Hot Line Power Hot
Orange	Ped Buttons

SECTION II–IMSA CABLES:

IMSA type cable shall be used where multiconductor cables are shown on the project plans feeding the traffic signal displays.

IMSA signal cables shall be polyethylene insulated copper conductors, black polyethylene jacketed, rated at 600 volts AC for use in underground conduit or as aerial cables conforming to International Municipal Signal Association (IMSA) specification numbers 20-1 and 20-3, as specified in the plans or Invitation for Bid.

The IMSA cable shall be provided with the number and size of conductors specified on the plans (#14 AWG unless otherwise noted). The cable shall use the standard IMSA colors and tracers shall be permanent and an integral part of the insulation.

Colors and uses shall be as follows unless otherwise pre-approved by the Traffic Signal Engineer or otherwise specified on the project plans:

Color	Circuit Use
Black	Yellow Arrow Ped Button #1
White	Logic Ground Ped Button (with green tape wrap) Commons

Red	Red Light Dont Walk #1
Green	Green Light Walk #1
Orange	Yellow Light Dont Walk #2
Blue	Green Arrow Walk #2
White/Black	Spare Ped Button #2

SECTION III–LOOP LEAD-IN CABLE:
Lead-in cables between the detector loops and the controller cabinet shall be a shielded single-pair cable, as described below. With prior approval from the Engineer a Multi-Pair cable as described below may be used.

Single-Pair Cable:
When specified in the plans or in the Invitation for Bid, single-pair #14 AWG cable with high-density, cross-linked polyester jacket conforming to IMSA Specification 50-2 shall be supplied. Wire conforming to this specification shall have two 7-strand conductors with shield. Single-pair cable shall be attached to the loops as shown in the project plans.

Multi-Pair Cable:
Cable shall be a multi-conductor cable with individually shielded pairs. Tinned copper stranded conductors shall be #18 AWG, polypropylene-insulated, twisted pairs, each pair with its #18 AWG stranded tinned copper drain wire under a 100% coverage aluminum-polyester shield and overall black high-density, cross-linked polyethylene outer jacket.

Colors provided shall be as follows:

1. Black paired with red.
2. Black paired with white.
3. Black paired with green.
4. Black paired with blue.
5. Black paired with yellow.
6. Black paired with brown.
7. Black paired with orange.
8. Red paired with white.
9. Red paired with green.
10. Red paired with blue.
11. Red paired with yellow.
12. Red paired with brown.

SECTION IV–INTERCONNECT CABLE:
Where interconnect circuits are to be provided, either an overhead or an underground system will be provided.

On overhead installations, the cable shall be a Figure "8" type unit with the span cable integrally molded to the cable itself. On underground conduit system installations, the cable shall have no span cable attached but otherwise be the identical cable.

Figure "8" type cables shall utilize a 1/4 inch [6 mm] diameter, 7-wire Extra High Strength galvanized steel messenger strand, integrated with the outer cable jacket. The jacket shall form a web between the messenger and cable, permitting suspension clamps to grip the jacketed messenger without damaging the cable jacket.

Three different interconnect configurations may be specified on the plans: Communications cable, 7-wire interconnect, or 12-pair Interconnect cable.

A 6 pair Communications cable shall be used if not otherwise specified in the plans.

Communications Cable: Communications cable shall conform to IMSA Specification 40-2 or 40-4 for twisted-pair cable, copper shielded, with high-density black polyethylene jacket. Conductors shall be #19 AWG solid, soft drawn, annealed copper. Conductor insulation shall be solid, high-density polyethylene 300 volt rating, with standard telephone industry color-coding.

Colors provided shall be as follows:

1. White paired with blue.
2. White paired with orange.
3. White paired with green.
4. White paired with brown.
5. White paired with slate.
6. Red paired with blue.

Communications cable shall contain 6 twisted pairs unless otherwise specified in the plans or Invitation for Bid.

7-Wire Interconnect: If the plans specifically call for a 7-wire or Type F interconnect, a 7-conductor IMSA cable meeting the IMSA cable specifications shall be used (IMSA 20-1 or 20-3, as applicable to the use).

12-Pair Interconnect: 12-pair interconnect shall conform to IMSA Specification 20-2-or 20-4 for #16 AWG, twisted-pair, copper-shielded, black-polyethylene 600 V. communications cable, with colors as specified herein.

SECTION V–WIRE TAGS

Wire identification tags shall be nylon tie-rap type cable ties with panels for marking with permanent ink. Nylon tags shall be approximately 3/8 inch [9 mm] by 1 inch [25 mm] in marking surface size or approved equal.

Colored nylon wire tags will be acceptable for tagging phase colors on individual wires in IMSA cables.

CONSTRUCTION METHODS

Wiring shall be done in accordance with the regulations and codes listed in the Regulations and Codes section of the NEC.

Conductors and cables shall be pulled into runs in a smooth continuous manner, avoiding contact with sharp objects that might damage the insulation. Approved lubricants shall be used for inserting conductors in the conduits. Before installation in conduits, conductor and cable ends shall be taped for moisture protection until connections are made.

All IMSA cable runs shall run UNSPLICED from the controller cabinet to the designated signal head(s), or pole terminal blocks if applicable. All detector cables shall run UNSPLICED from the controller cabinet to the pull box adjacent to the loop detector in the street. Power wires from the service disconnect pole or cabinet shall run unspliced from that unit to the controller cabinet. Bare bond wires (ground) may be spliced in pull boxes using split-bolt connectors ONLY.

All cables and conductors shall have 2 feet [610 mm] of slack in pull boxes.

IMSA cables shall be stripped back and individual wires identified and tagged with the nylon tags as to phase, color indication, and function (Phase 1-Red, Phase 2-Walk, Power Hot, etc.) in the controller cabinet. All other conductors shall be tagged or in the case of detector cables identified by means of colored plastic tape according to the following scheme:

Phase Served	Tape Color
1	Violet
2	Red
3	Blue
4	Orange
5	Green
6	Brown
7	Black
8	Yellow

Interconnect cable runs shall have splices at the intersections as shown on the plans. Splices between intersections shall be minimized and should be spaced at least 300 feet [91 m] apart if possible. When splicing Figure "8" type cable, continuity of the span cable shall be accomplished by means of cable clamps and a #6 stranded bond wire if the messenger is not continuous.

Extra wires in cables shall be considered spares and shall be coiled neatly out of the way and tagged as such.

IMSA cables, and power cables shall be tagged, and all detector cables shall be color taped in each and every pull box they pass through, except the pull box in the controller cabinet foundation.

All metallic items such as cabinets, pedestals, span wires, signal mountings, metal conduit, and poles shall be bonded to form a continuous ground system. Non-metallic portions of the system such as PVC conduit shall have a #6 solid bare copper bond wire installed with suitable connections to effectively ground the system.

Wires shall be contained within the mounting assemblies of all signal mountings, and not be exposed, with the exception of a span-wire type of mounting arrangement.

Span wires attached to wood poles shall be bonded together at each pole with a #6 bare bond wire and cable clamps. On each pole, spans shall be grounded through #6 bond wires stapled to the pole and clamped to the ground rod.

Service system components and their installation shall conform to regulations and codes applicable from the NEC, local codes, and CPS service regulations.

MEASUREMENT AND PAYMENT

Cables and conductors shall be measured for payment as a lump sum unit of work per intersection or as quantified in the bid list line item units, which shall be full compensation for the item including installation and incidentals.

No measurement or direct payment shall be made for cables and conductors in poles and pull boxes, the cost being considered as included in the cost of the pole or pull box items.

BID ITEMS:

Item 630.1: Cable and Conductors (per intersection)

Item 630.2: Linear Feet [meter] of Cable

Item 630.3: Linear Feet [meter] of Interconnect Cable

ITEM 631
CABLE TRANSFER

The purpose of this specification is to describe a procedure for the transfer of existing overhead cable from existing poles to new pole locations.

MATERIALS:

All new cable, required to replace damaged existing cable, shall conform to the City of San Antonio, Standard Specification 630, Cable and Conductors, unless otherwise specified herein.

Electrical conductors shall be thermoplastic insulated electrical wire or cable as described on the plans. Cables shall conform to the National Electrical Code (NEC), Underwriters Laboratories (UL) standards, International Municipal Signal Association (IMSA) specifications, Rural Electrification Administration (REA) and other applicable industry standards. All materials and workmanship shall conform to the requirements of the plans, these specifications, and special provisions, and to any other codes, standards, or ordinances which may apply. Whenever reference is made to any of the standards mentioned above, the reference shall be considered to mean the code, ordinance, or standard that is in effect at the time of the contract letting.

When additional mounting hardware is required it shall consist of a 14 inch [355 mm] machine bolt drilled all the way through the wood pole and attached with associcated equiptment. A figure "8" cable suspension clamp of either the one bolt-type with J hook or the three bolt-type with J hook shall be used.

Aerial enclosures shall be a Reliance brand No. 100MC closure or equivalant. If required, overhead splice boxes shall be 16 gauge aluminum, NEMA Type 3R pull boxes, with a standard finish and measuring 6 inches [152 mm] deep, 8 inches [203 mm] wide and 10 inches [254 mm] high.

Wire identification tags shall be as described in Standard Specification 630, Cable and Conductors and will be used to tag interconnect cables in the traffic contoller cabinet.

CONSTRUCTION METHODS:

The Contractor shall be responsible for contacting the owner/agency of the existing utility poles to which the existing interconnect cables are attached to determine if the poles will be topped or salvaged by the respective owner/agency.

Wiring shall be done in accordance with the regulations and codes listed in the Regulations and Codes section of the NEC.

When the Contractor is to make terminations, extra wires in cables are to be considered spares and shall be terminated on spare positions and tagged as such.

On wood poles, spans shall be grounded through #6 bond wires stapled to the pole and clamped to a ground rod. Ground rods shall be placed approximately every 300 feet [91m].

Salvaging or Reinstalling Equipment

Serviceable existing equipment shall be salvaged and reinstalled. The contractor shall furnish all necessary additional materials, equipment, and hardware as required to complete the transfer of existing interconnect cable to the designated new location. If the Contractor is uncertain as to whether salvaged hardware can be re-used, the Contractor can request a field inspection of the hardware by contacting the Traffic Signal Engineer.

Utility poles will be adjusted by their respective owner/agency. After the utility poles are relocated, the Contractor shall relocate the existing interconnect cable to the newly installed poles to complete the interconnect transfer.

All equipment damaged or destroyed by improper care or handling shall be replaced by the Contractor at his expense with new equipment. Unless otherwise specified, it shall be the responsibility of the Contractor to remove and dispose of all discarded materials not salvaged.

Maintaining Existing Signal System:

All existing traffic signal interconnect systems or other designated electrical systems shall be kept in effective operation for the benefit of the traveling public during the progress of the work. Upon specific approval of the Traffic Signal Engineer, the Contractor will be allowed to briefly disconnect the interconnect and communications cable when necessary. Interconnect and communications cable is energized at all times and shall not be cut without advance coordination with the Traffic Signal Engineer.

During construction, the maintenance, care and control of the existing traffic signal control cabinet will be the responsibility of the City. All other maintenance of the existing interconnect system shall be the responsibility of the Contractor.

The Contractor shall check to insure that the minimum vertical clearance is maintained and shall take corrective measures, if necessary, at his expense. The

interconnect cable shall have a maximum sag of five percent of the distance of the span. The minimum clearance at the middle of a span shall not be less than 15 feet, six inches [4.7m].

Splices:
All overhead splices for interconnect cable shall be made using an aerial closure (Reliance 100MC or approved equal) and three pair terminal blocks (Reliance 145P or approved equal) in sufficient numbers to ensure all wires have their own terminal positions.

Underground interconnect cable shall be spliced in the pull box using a 3M 3370 Connector Sealing Pack or approved equal.

MEASUREMENT AND PAYMENT:

Unit Price Bid - Cable transfers shall be measured for payment by the linear foot or as quantified in the bid list line item units, which shall be full compensation for the item including installation and incidentals.
Full compensation for all materials and labor not shown on the plans or specified, such as all required mounting hardware, splice kits, making all electrical connections and splices which are necessary to complete the installation of the various systems, shall be considered as included in the prices paid for the systems or units thereof, and no additional compensation will be allowed.

BID ITEMS:

Item 631.1: Linear Feet [meter] of Cable

Item 632.2: Cable Transfer (per contact)

ITEM 632
ELECTRICAL SERVICE

The purpose of this specification is to describe the procedures and requirements for electrical service from either a ground-mounted cabinet or wood service pole. The work shall consist of furnishing and installing service pedestal or wood service pole as shown on the project plans and these specifications including the detail drawing.

MATERIALS:

All materials shown on the applicable detail shall be supplied as part of this item as described on the detail.

The lengths of wood poles shall be 25 feet [7.6 m] for service poles. Class 4 or 5 may be used for service poles.

Wood poles used for wood pole service installations shall conform to Item 622, Wood Poles.

Service risers shall be rigid galvanized steel of the size shown on the plans all the way to the next pull box or cabinet.

Fastening of the service risers and all other conduits on the pole shall be done via the use of 2-hole straps and wood screws a minimum of 1 1/2 inches [38 mm] in length. Tape, nails, and drive hooks are not acceptable.

All safety switch and breaker enclosures shall be padlockable to prevent unauthorized persons from tampering with the disconnect.

Disconnect box to be a weatherproof box containing breakers. Box shall NOT have an external switch. Breaker box shall have a 120/240 volt lightning arrester installed for surge protection.

CONSTRUCTION METHODS

Cables, conductors, conduits, or any other attachments made to CPS poles shall not be done without the CPS-required insurance defined in Item

601, "CPS Insurance". The Contractor shall use the utmost care when contacting any CPS poles or equipment and shall bear the cost of any repairs necessary from Contractor damage to any CPS facility.

The service shall be the first item of construction at any location requiring new service. The Contractor shall be responsible for contacting CPS immediately and setting up a field meeting for determining the quadrant of the pole on which the riser shall be located.

On service pedestal type services, before the conduit is encased in concrete and before it is backfilled it must be inspected by a CPS Inspector. City or other Inspectors do NOT make this inspection. Two inspections are required for concrete-encased conduits; only one for all others. For inspections, call the CPS Customer Services Department representitive for the location. Inspections shall be requested at least 24 hours in advance. When this inspection procedure is not followed, CPS has the right to require the Contractor to remove part or all of the concrete and/or backfill to expose the conduit.

The Contractor shall supply and install the address in permanent numbers and letters to the street side of the service enclosure. Said address shall also be recorded and given to the Traffic Design Engineer for the City's records.

The Contractor shall arrange and pay for all permits, inspections, and service arrangements. Upon final acceptance, the Traffic Design Engineer shall authorize CPS to read the meter and initiate billing in the City's name. Any and all charges prior to that time shall be the responsibility of the Contractor.

Failure to settle such charges with CPS may be cause for the City to take appropriate action against the Contractor. The City shall not pay prior charges incurred by the Contractor.

Power requirements shall be 120 volt, single-phase, 60 cycle AC supply.

MEASUREMENT AND PAYMENT

Electrical service shall be measured for payment as a lump sum unit per intersection, in accordance with the plans and specifications. The accepted number of electrical services shall be paid for at the contract unit price which shall be full compensation for the service unit, pedestal or pole, all associated equipment shown on the referenced detail, labor, permits, inspections, and incidentals.

BID ITEMS:

Item 632.1: Electrical Service Pedestal

Item 632.2: Electrical Service Pole

Item 632.3: Electrical Service on Signal Pole

ITEM 634
DETECTOR LOOPS

The purpose of this specification is to describe detector loops for use in a traffic signal system. The work shall consist of furnishing and installing all sawcutting, barricading, wire, sealant, labor, and incidentals required in accordance with the project plans and specifications.

MATERIALS:

Sawcut Loops

Loops designated on the plans as loops to be sawcut into the pavement shall utilize loop wire with the following features:

Loop wire shall be single-conductor #14 stranded copper wire with a black cross-linked polyethylene (XHHW) insulation rated at 600 volts.

The wall thickness of the insulation shall be at least 30 mils. The wire shall conform to IMSA Specification 51-3-1984.

The sealant shall be a one-part elastometric sealant which may be used to seal slots in portland cement concrete pavement, asphalt, and lean concrete base.
The sealant shall conform to Item 634A Sealant.

Conduit Encased Loops

Conduit and fittings shall be standard electrical conduit, UL listed, meeting the requirements of Item 628 Traffic Signal Conduit.

Loop wire shall be single-conductor #14 stranded copper wire with a black cross-linked polyethylene (XHHW) insulation rated at 600 volts. The wall thickness of the insulation shall be at least 30 mils.
The wire shall conform to IMSA Specification 51-3-1984.

Lead-in conduit shall be either intermediate metal conduit as shown on the Standard Detail, or rigid metal conduit may be substituted at no additional cost to the City.

CONSTRUCTION METHODS:

Detector loops shall be installed as shown on the project plans and Standard Details. The installation of the detectors shall be such that the operation shall not be affected by temperature changes, water, ice, rain, snow, chemicals, or electromagnetic noise.

All loops placed in areas to be paved or overlayed shall be installed prior to the final pavement course.
Care shall be exercised when laying out sawcutting slots so that the loop wire never is installed in any turn greater than 45 degrees. Backer rods shall not be used in loops. Small pieces of filler material such as duct seal may be used to hold wires in place, but they should be small enough and widely-spaced enough to eliminate the possibility of inhibiting the full encapsulation of the loop wire.

Saw cuts shall be sealed with the specified sealant. All slots in the pavement shall be blown out and dried before installing conductors. Before the sealant sets up, surplus sealant shall be removed from the road surface leaving a neat line of sealant on the saw slot only. Sand may be used to cover the new sealant to facilitate traffic use of the lane prior to complete set up of the sealant.

Loop detector wires shall be spliced in the pull box adjacent to the loop location as shown on the plans.
All detector loop splices shall be soldered using resin core solder with 60% tin and 40% lead. The splices shall be sealed from moisture with self encapsulating electrical insulating resin, or approved heat-shrink encapsulation.

The Contractor shall perform an insulation resistance-to-ground test on all new loops and provide written results to the Inspector. The insulation resistance-to-ground shall be at least 50 megohms when measured at a voltage between 400 volts and 600 volts DC.

Any loop detector that does not meet the above values on the resistance-to-ground test shall be replaced by the Contractor.

All loops shall be centered in the lanes they are to serve.

Stub-out conduits where no curbing exists shall extend into the pavement a minimum of 12 inches [305 mm] before they come up to the surface. Holes at the stub-out location, be they in curbed or uncurbed areas, shall be patched with asphalt, not loop sealant.

MEASUREMENT AND PAYMENT:

Unit Price Bid - Detector loops shall be measured for payment by the line item description in the bid list which may be per unit each of a conduit-encased loop (including the conduit into the pull box) or by the linear footage of sawcut measured from the stubout location, around the loop, and back to the point of where the cut to the stubout connects to the loop (all the sawcut footage [meter]). Wire, sealant, and incidentals shall not be paid for directly, the cost of which shall be included in the price for the loop.

BID ITEMS:

Item 634.1: 6x6 Conduit-Encased Loop

Item 634.2: Linear Feet [meter] of Sawcut

ITEM 636
STREET LIGHT FIXTURES

The purpose of this specification is to describe a street light fixture for use in a traffic signal/street lighting system. The work shall consist of furnishing and installing the street light fixture, lamp, and photocell as described herein and on the project plans.

MATERIALS:

The street light fixtures shall be 250 or 400 Watt as shown on the plans, high pressure sodium, horizontal burning, cobra head shape type. The housing, together with the refractor shall be of sufficient size to properly utilize the lamp. The light distribution shall be Medium Semi-cutoff Type III unless otherwise specified, and shall conform to the Illumination Engineering Society (IES)Standards.

All fixtures shall be supplied with photocell fixtures integral to the fixture. Photocells shall be rated for the nominal supply voltage and capable of handling the designated maximum line load. Photocells shall be designed or adjusted to turn on with an ambient light level of 1.0 footcandle $\pm$ 0.2 footcandles (10.76 lux $\pm$ 2.15 lux), and turn off with an ambient light level of 1.8 footcandles (19.38 lux).
For each fixture, the City shall be supplied with an instruction sheet which clearly shows installation procedures and instructions for adjusting the lamp socket. The instruction sheet shall include complete information on all socket positions and the IES light distribution produced from each setting.

The fixture housing shall be fabricated from a noncorrosive material. All fixtures shall have a Lexan refractor and a removable regulator ballast module rated for the wattage of lamp indicated on the plans.

Lamps shall be the high pressure sodium, horizontal burning type. Each lamp shall be marked with the manufacturer's reference number and wattage. All lamps shall have a rated life of at least 24,000 hours, with the following characteristics:

Wattage	Lamp Voltage	Minimum Initial Lumens
250	100	30,000
400	100	50,000

The ballast module shall contain all the major electrical components and shall be capable of being lowered. The ballast shall be prewired to the lamp socket and terminal board. The ballast module assembly shall be removable and replaceable by the use of quick-disconnect plugs.

The optical assembly holder shall be a one-door design and have an automatic latch with a safety catch. The holder shall be forced upward at the street side by spring pressure against the resilient polyester fiber gasket when in the closed and latched position.

The fixture shall have a two-bolt slipfitter for mounting on a two inch [50 mm] nominal diameter mast arm tenon and shall be adjustable for leveling.

CONSTRUCTION METHODS:

All street light fixtures shall be installed according to the manufacturer's instructions, and leveled once installed in the field.

Photocells shall be installed or adjusted so that their eye door faces to the north and that they turn on and off at the specified ambient light levels.

The Contractor shall field test the photocell operation by blocking out all light to the cell and verifying the fixture will start up under that condition.
Any failures of the lamp, fixture, or photocell prior to final acceptance and completion of the overall system warranty shall be repaired or replaced by the Contractor at his expense.

MEASUREMENT AND PAYMENT:

Street light fixtures shall be measured for payment by the number of units each, complete in place in accordance with the plans and specifications.

The accepted number -of street lights shall be paid for at the contract unit price which shall be full compensation for the street light fixtures, lamps, photocells, installation, and incidentals.

BID ITEM:

Item 636: Street Light Fixtures (ea.)